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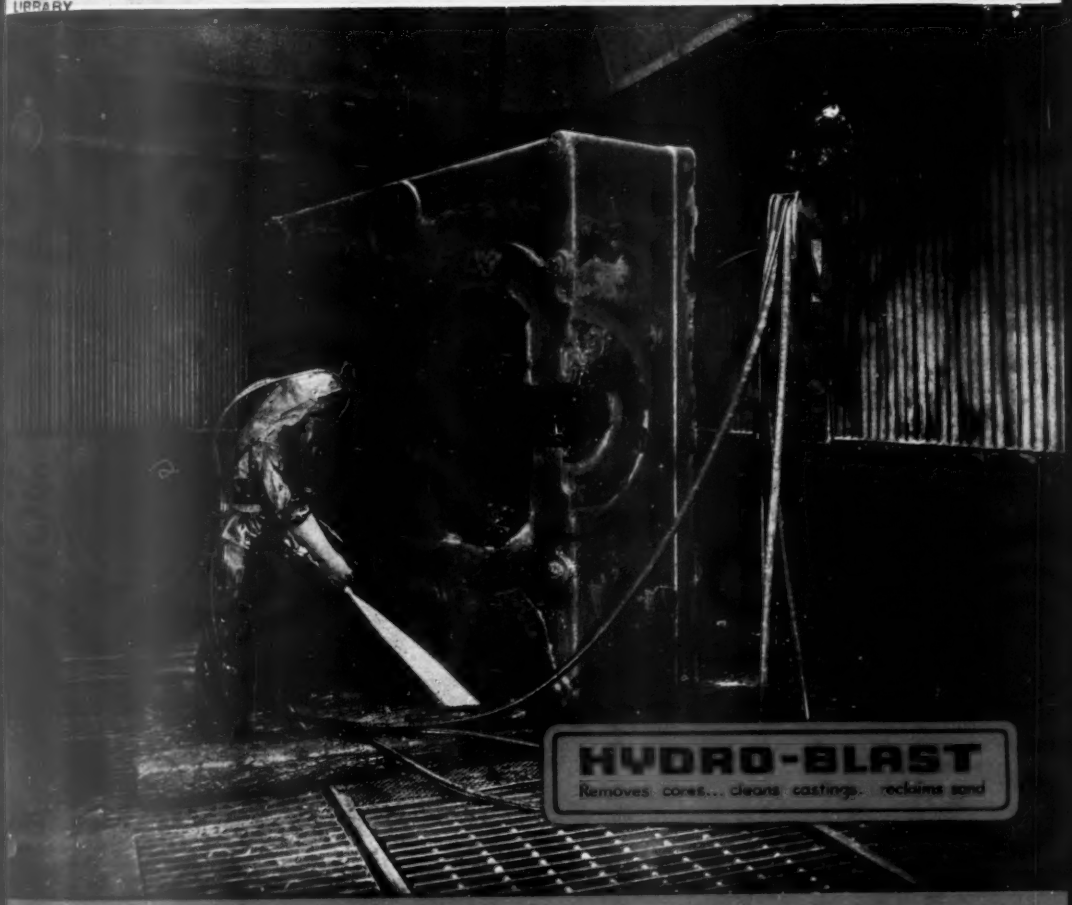

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PRINCIPAL CONTENTS

Technical: PAGE

Influence of Magnesium Content on Layer Porosity and Tensile Properties of Sand-cast Aluminium/Magnesium Alloys, B.S. 1490—LM 10 and B.S. (Aircraft) L.53, by R. Jay, B.Sc., A.I.M., and A. Cibula, M.A., A.I.M.: Communication from the British Non-Ferrous Metals Research Association embodied in a Paper presented at the annual conference of the Institute of British Foundrymen, which was held in Cardiff, in June 131

Surface Defects in Some Sand-Cast Stainless Steels, by B. H. C. Waters, Carl Hayward and Howard F. Taylor: An account of experiments carried out to prevent the "measles" defect observed in stainless-steel alloys of the CA 15-type when cast in green-sand moulds. The results of field trials of the cure proposed are also recorded, as are numerous ancillary tests 143

Features:

Leader: Fewer Foundry Establishments . 127
Featuring—Sir George H. Nelson . 128, 129
Law Cases and New Catalogues . . 152
House Organs (Advert. section) . . 35

Commercial:

Steel Production Lower 151
New Patents and Company News . 153
Raw Material Markets 156
Current Prices of Iron, Steel and Non-Ferrous Metals 158
Pig-iron and Steel Production in May (Advert. section) 34
Contracts Open (Advert. section) . . 35

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Fewer Foundry Establishments

We are often asked how many foundries there are in Great Britain, which we assume to include Northern Ireland, and glibly we answer, 4,000. As a new edition of Ryland's Directory is currently available, a count has been taken and the total, excluding die-casting concerns, is 4,086. An examination of this figure shows that it needs pruning, for example, the first firm to appear in the geographic listing of each of the three groupings—cast-iron, brass and aluminium founders—is J. Hobkirk Sons & Company, Limited. Then again, some concerns have a number of separate plants and are listed according to their locations; of this type are the Coal Board and the Stanton Ironworks Company. The individual plants of these concerns can be regarded as separate entities, but to deal with the case where foundries make more than one alloy in the same building, we think a reduction of some five per cent. on the gross total should be made, taking into account that many ironfounders have facilities for making brass castings and the like, but do not think it worth while to announce the fact. It is interesting to note that when we made a census on the same basis in 1938, there were 4,774 foundry concerns; thus there has been a decline of 688 in the intervening period, though the former figure included about 50 foundries in the Irish Republic.

There are to-day listed 1,969 ironfoundries whilst in 1938 there were 2,739, a reduction of 17 per cent. in the intervening years. This is not serious, as it is the output of the largest concerns which really affects production. The malleable iron foundries listed number 132, just nine fewer than before the war, when we stated that this country used a less quantity of malleable iron *per capita* than any of the other great industrial nations. On the present showing, the steel foundry industry has lost six foundries and there are 132 units, though we noticed in this list the inclusion of an investment-casting foundry. Under this last heading, quite a few additions could be made—yet they are not strictly steelfounders especially from the supply angle. The one section of the industry where, as we forecast in 1938, there has been an increase in numbers is that devoted to the casting of aluminium. Here there has been an increase of 30, and now number 411.

These statistics, in general, follow the American trend; moreover modern legislation will accelerate the movement—which is not to be associated with either decreased production or value of output, but rather the tendency for big foundries to become bigger. This is due to the adoption of mechanized manufacturing methods which demand large outputs for economic exploitation. Very unfortunately it is the small jobbing foundry which ceases production, yet in country areas these small works do very useful service in keeping the wheels of local industry running smoothly and in this work they are irreplaceable.

Featuring . . . .

SIR GEORGE H. NELSON, Bt.

SIR GEORGE H. NELSON, Bt., executive chairman of the English Electric Company, Limited, ranks amongst the great industrial leaders of the present time. His services to industry and his work in the field of technical education are widespread, as may be judged from the numerous societies, councils, associations and educational bodies to which he gives close and tireless attention. He is president of the Institution of Electrical Engineers and a former vice-president of the Institution of Mechanical Engineers. For two years, from 1943 to 1945, he was president of the Federation of British Industries and he has been a member of the Federation's Grand Council for the past thirteen years. He is a Governor of Queen Mary College (University of London) and an honorary member and Fellow of the Imperial College of Science and Technology. In the Birthday Honours, 1955, he was created a baronet.

Sir George was born in London, and before he was 18 years old he took his diploma at the City and Guilds Technical College, London, where he received his early training; he has since been made a Fellow of the College. He was awarded the Mitchell Exhibition and a post-graduate Brush studentship, and became a premium pupil of the Brush Electrical Engineering Company, Limited, Loughborough. Later he joined the British Westinghouse Company, now Metropolitan-Vickers Electrical Company, Limited, and by 1920, when he was only 33, he established and became manager of their Sheffield works. His association with the English Electric Company started in 1930, when he was appointed managing director; three years later he became chairman. Under Sir George's guidance English Electric has expanded almost beyond recognition. As an example of his foresight, it is sufficient to recall that in the depths of the depression he had the courage to build one of the finest research organizations in the world—the Nelson research laboratories at Stafford. In the course of 25 years he skilfully created out of the organization he had taken over, a great group of companies, including D. Napier & Son, Limited, the Marconi organization, and the Vulcan group, which includes Robert Stephenson & Hawthorns, Limited; several of the constituent firms, in addition to the parent concerns, have large foundries. To-day the companies of the English Electric group employ nearly 70,000 people and manufacture a complete range of industrial capital equipment.

During the war years, the English Electric Company achieved an enormous output of war material, including many thousands of tanks and aeroplanes. Sir George's personal contribution to the war effort was great and in 1943 he was knighted for the public work he had done. Out of his war effort grew his interest in military aircraft which led him to inspire the designing of the record-breaking Canberra bomber and later Britain's new supersonic interceptor fighter, the P.1.

Sir George's main recreation in his limited amount of free time is shooting.

SIR GEORGE H. NELSON, Bt.

Chairman, English Electric Company, Limited

35-ton Gearing for Steelworks

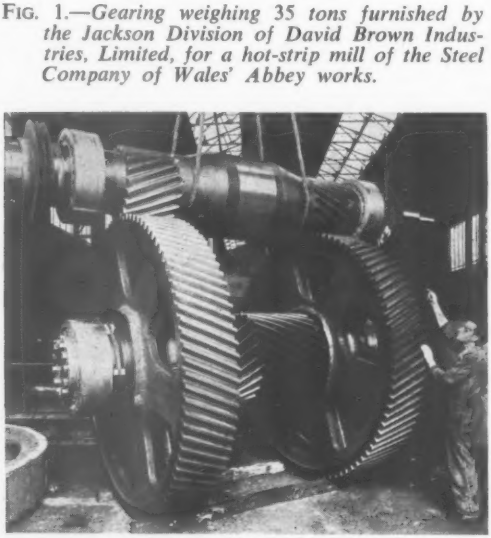
As part of the drive to the broadside mill stand in the roughing section of a hot-strip mill at the Steel Company of Wales, Abbey Works, Port Talbot, the Jackson Division of David Brown Industries, Limited, has recently supplied the 35-ton set of gears, shown in Fig. 1, embodying cast gear-wheels. The two wheels, each with 16-in. helical face, have 90 teeth of 1 D.P. and engage with pinions made from forgings. They are mounted on a forged-steel first motion shaft, which drives the stand through 24 double-helical teeth of ½ D.P. on a 57-in. face. Seen mounted above the wheels is the motor extension-shaft, with two sets of 20 teeth and provision for mounting on each end a flywheel 12-ft. dia.

The work rolls in this mill stand are 42-in. dia. and 130-in. long, with back-up rolls 54-in. dia. The mill is used for normal single-pass reductions and for cross-rolling of slabs up to 74-in. wide for the subsequent production of sheets and plates. Power is provided by a 3,500 h.p. motor at 495 r.p.m., and the drive to the mill is reduced by a ratio of 25.86:1 by a gearbox in which this David Brown set forms part of the train.

Large Chainwheels

Another unusual order, currently being fulfilled by the same firm, is the manufacture of a number of large chainwheels for use in paddle-driven tugs, the first two of which—H.M.T. Director and H.M.T. Dexterous—are being built for the Admiralty by Yarrow & Company, Limited, of Scotstoun, Glasgow. Ordered by Renold Chains, Limited, of Manchester, the chainwheels are designed to form part of main-reduction drives from 800 h.p. diesel/electric motors to the paddle shafts. Each wheel is cast in halves, which are bolted together. The 36½-in. outer face is turned on a vertical boring mill and is recessed to take four triplex chains. Finally, the twelve sets of 136 teeth of 2½-in. pitch are cut to fine limits of accuracy with a special set of rotary cutters. The tugs in which these chain drives are to be installed are intended primarily for harbour service.

FIG. 1.—*Gearing weighing 35 tons furnished by the Jackson Division of David Brown Industries, Limited, for a hot-strip mill of the Steel Company of Wales' Abbey works.*



National Council for Technological Awards

In an addendum to the memorandum on the "Recognition of Courses in Technical Colleges leading to the Diploma in Technology," issued by the National Council for Technological Awards, paragraphs 23 and 24 are now replaced by the following:—

Fees and Charges

23. The college will be required to reimburse the Council for expenditure incurred when a visit is necessary in connection with the consideration or review of a course.

24. In addition a fee of £26 5s. will be charged for the consideration of each application for the recognition of a course. Recognition, when given, will be subject to review every five years and a further fee of £26 5s. will be payable at each review.

25. A registration fee of £10 10s. will be charged for the conferment of the diploma in technology.

26. Fees should not be remitted until a request for payment is made.

Submission of Applications

27. Applications for the recognition of courses for the award of the diploma should be made on forms which will be available on application to the Council.

28. The Council are prepared to consider, on their merits, applications in respect of new courses which are regarded as meeting the requirements set out in the memorandum (N.C.T.A.1) and in respect of existing courses which either meet those requirements or which it is proposed to modify to that end. Full particulars of the modifications proposed should be submitted with these applications.

Forty Years Ago

In the August, 1916, issue of the JOURNAL, the Editor supported the suggestions that were being made for the creation of a "Ministry of Science." It was only a month before the Department of Scientific and Industrial Research published its first annual report, and this has served industry just as well as a Ministry. Possibly this issue carried the first description of a mechanized foundry, actually the cylinder shop of the Ford Motor Company, Limited, at Detroit. The only claims made for it were continuity of production, reduced manufacturing space and an improved atmosphere. A Government regulation was printed showing, for ironfoundries engaged in manufacturing or repairing machinery or plant for use in industry, all classes of workmen were exempt from military service. Amongst "New Companies" registered there appeared the names of Elliott Brothers (London), Limited, T. M. Birkett & Sons, Limited, Cardiff Foundry & Engineering Company, Limited, and Stein & Atkinson, Limited.

Light Metals Conference

The third International Light Metals Conference was held on June 7 to 9 at Leoben, Austria. Organized by the Montanistische Hochschule, Leoben, with the assistance of the Austrian light-metals industry, it was attended by over 350 technical representatives from 19 countries. The activities included demonstrations of the applications of light-metals, various social functions and a full programme of technical meetings at which about 30 papers were presented, covering all phases of the industry.

Influence of Magnesium Content on Layer Porosity and Tensile Properties of Sand-cast Aluminium/Magesium Alloys, B.S. 1490-LM10 and B.S. (Aircraft) L.53*

By R. Jay, B.Sc., A.I.M., and A. Cibula, M.A., A.I.M.

Test-bars of 1-, 1½- *and* 4-*in. diameter were cast from gassy and degassed melts containing from* 9 *to* 14 *per cent. magnesium,* 0.004 *per cent. beryllium and grain-refiners; shrinkage porosity was deliberately introduced into some bars by incompletely filling the feeder-heads. Porosities, tensile strengths and elongations were then determined after solution-treatment. The D.T.D. bars contained about* 0.9 *per cent. more magnesium than the melt from which they were cast, owing to the feeding of magnesium-rich liquid from the heads.*

In D.T.D. bars containing 10.8 *to* 12 *per cent. magnesium and poured from degassed melts, microporosity was uniformly distributed and the maximum tensile properties were obtained. Bars with more than* 12 *per cent. magnesium contained undissolved* β*-phase and were brittle; in bars having less than* 10.8 *per cent. magnesium, layers of microporosity occurred which seriously reduced the tensile properties. Lack of feeding and—to a lesser extent—gas intensified layer-porosity, whatever the magnesium content. The properties of larger bars were low and much less influenced by their magnesium content. The formation of layer-porosity is discussed and comparison made with coarse-grained aluminium/magnesium alloys and with aluminium/*4½ *per cent. copper alloys.*

Introduction and Summary

The aluminium/9.5-11.0 per cent. magnesium alloy (B.S. 1490—LM10 and B.S. (Aircraft) L53 (Table I)) is well known for its high strength, ductility, and resistance to shock, and excellent corrosion resistance, particularly in marine conditions; moreover, it is less susceptible to hot-tearing than the alternative material for high-strength castings, the aluminium/4½ per cent. copper alloy (B.S. 1490—LM11). However, the aluminium/magnesium alloy has always presented greater difficulties in casting than other aluminium alloys because (*i*) it drosses more heavily during melting, (*ii*) it readily absorbs gas while molten and (*iii*) it reacts with moisture in sand-moulds giving rise to porosity and surface oxidation (metal/mould reaction); further, as with other alloys which freeze over a long temperature-range, feeding, adequate to produce castings tolerably free from shrinkage cavities, is difficult.

TABLE I.—*Minimum Specification Requirements for the Aluminium 9.5—11 per cent. Magnesium Alloy.*

—	Spec. B.S. 1490-L.M.10.		Spec. B.S. L53.	
	Tensile strength, tons per sq. in.	Elongation, per cent.	Tensile strength, tons per sq. in.	Elongation, per cent.
D.T.D. Bar..	18	8	18	8
E Bar ..	18	8	18	8

These drawbacks have been investigated in the Association's earlier work on the casting of light alloys; it has been found[1] that metal/mould reaction may be controlled by the addition of as little as 0.004 per cent. beryllium to the metal and boric acid to the sand and that adequate grain-refinement may redistribute microporosity so that it is less harmful[2]. It has also been shown by Parker, Cox and Turner[3] that the silicon content of the alloy must be held below 0.2 per cent. in order to restrict the amount of the deleterious grain-boundary constituent Mg_2Si.

*Communication from the British Non-Ferrous Metals Research Association presented to the Institute of British Foundrymen at the annual conference in Cardiff last month. The work described in this Paper was made available to members of the BNFMRA in confidential research reports issued in 1953 and 1954.

MR. R. JAY, B.SC., A.I.M., A.C.T. (B'HAM), is development engineer with the British Aluminium Company, Limited, specializing in aircraft alloy developments. He was educated at King Edward's Grammar School, Birmingham, joined the research and development staff of the Mond Nickel Company, Limited, as a laboratory assistant. After qualifying for an external B.SC.(ENG.) degree of London University, he spent three years on the senior research staff of the company. From 1949 to 1954, he was liaison officer at the British Non-Ferrous Metals Research Association.

MR. A. CIBULA is an investigator at the British Non-Ferrous Metals Research Association, which he joined in 1947. His researches include work on melting and casting, particularly grain-refinement of light and copper-base alloys. He studied natural sciences and metallurgy at Cambridge University from 1940 to 1942 and 1946 to 1947, and obtained first-class honours in Part II, Natural Sciences Tripos; in 1947 he was awarded the degree of M.A. In between, Mr. Cibula was assistant to the works metallurgist at Standard Telephones & Cables, Limited, North Woolwich.

Despite these improvements in technique, however, considerable variation in the tensile properties of sand-cast test-bars is still observed and it was suggested by a member firm that the low tensile-properties were associated with a low magnesium-

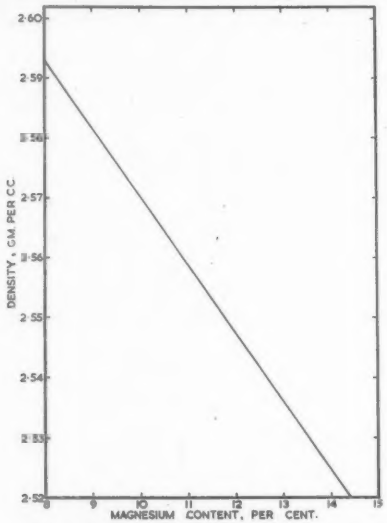


FIG 1.—*Effect of magnesium content on the density of sand-cast test-bars of* 1 *in. dia.*

content. This suggestion agreed with earlier work by the Association[4], which showed that in test-bars containing about 12.5 per cent. magnesium, high tensile-strengths could be obtained without sacrifice of ductility, while bars, which had been deliberately made porous by insufficient feeding also had higher tensile-properties than similar bars containing only 10 per cent. magnesium.

In the present work, the effects of magnesium content, gas content and lack of feeding on the tensile properties of aluminium/magnesium alloys were studied by casting D.T.D. test-bars of various magnesium-contents from gas-free and gassy melts, some of the feeder-heads being incompletely filled. The effect of the size of the test-bar and the influence of grain size on the formation of porosity were examined and the alloys have been compared with bars cast in aluminium/4.5 per cent. copper alloy. The effect of mould hardness on the soundness and tensile properties of E-bars in aluminium/11 per cent. magnesium was also determined as this appeared to be significant.[5]

Main Conclusions

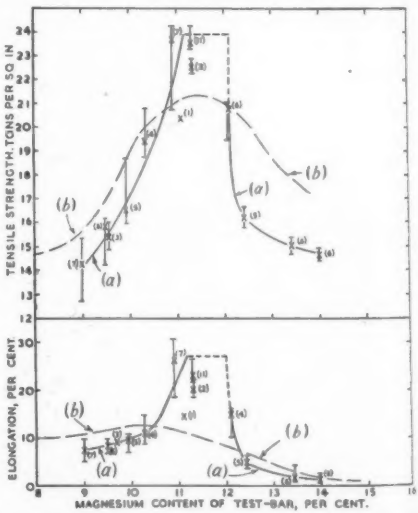
The conclusions drawn from the results are summarized below. As stated in the final conclusion, the magnesium contents of the test-bars were considerably higher than those of the melts from which they were cast: each magnesium content quoted below is generally the average content of a fully-fed bar.

(1) The magnesium content is an important factor influencing the form of porosity and the tensile properties of sand-cast D.T.D. bars. Test-bars of more than 10.8 per cent. magnesium poured from degassed melts have uniformly-distributed voids and high properties, whereas in bars of lower magnesium-contents, the porosity is concentrated in layers which have a deleterious effect on the tensile properties. The optimum tensile-properties are obtained when the magnesium content of the test-bars is between 10.8 and 12 per cent. magnesium; taking into account the segregation of magnesium in the test-bar, the optimum magnesium-content of the melts would be 9.9 to 11.1 per cent., a range which lies almost entirely within the specified range for the alloy. The tensile strength of D.T.D. bars of less than 10 per cent. magnesium poured from degassed melts is below 18 tons per sq. in. The properties of 1½-in. dia. bars are similarly affected by magnesium content, though their maximum ductility is low.

(2) In D.T.D. test-bars of high magnesium-content (10.8 to 12 per cent.), dissolved gas produces only moderate layer-porosity which reduces the tensile strength from between 22 and 24 to 18 tons per sq. in., and the elongation from 28 to 10 per cent.; even with gross gas-porosity, however, the properties are better than those obtained with gas-free test-bars of low magnesium-content.

FIG. 2.—*Influence of magnesium content on tensile strength and elongation of* 1 *in. dia. test-bars poured from degassed melts.*

Key: (*a*) 1-in. dia. test-bars, heat-treated for 16 hrs. at 425 deg. C.; the figures in parentheses indicate the number of bars tested, the vertical lines indicate the range of results with X at their average; (*b*) results for ½-in. dia. bars after Sicha and Keller.[6]



(3) Irrespective of magnesium content, lack of feeding in 1-in. dia. D.T.D. bars results in severe layer-porosity, and a correspondingly sharp fall in

tensile properties. In these castings, dissolved gas can produce a moderate improvement in tensile properties by modifying the form of porosity.

(4) Bars of 4-in. dia. respond less quickly to solution treatment than 1-in. dia. bars but the maximum properties are obtained after 16 hours at 430 deg. C. These properties are very much less influenced by magnesium content than those of 1-in. dia. bars and are much lower owing to extensive microporosity.

(5) Layer porosity occurs in both fine-grained and coarse-grained aluminium/magnesium alloys but the latter are more unsound and have considerably-lower tensile properties.

(6) The tensile properties of aluminium/magnesium alloys are sensitive to small variations in casting conditions which affect the incidence of

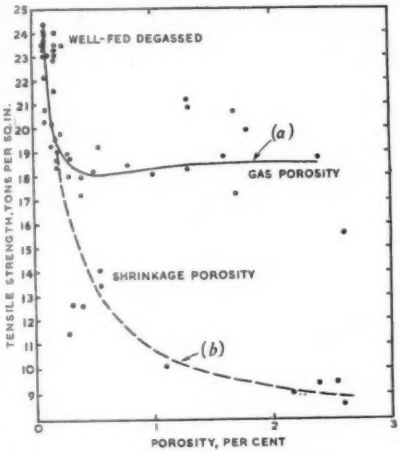


FIG. 3.—*Effect of gas- and shrinkage-porosity on the tensile strength of* 1 *in. dia. test-bars containing* 10.9 *to* 12.1 *per cent. magnesium.*

Key: (*a*) well-fed bars, some from gassy melts, (*b*) bars with incomplete feeder-heads, from degassed melts.

layer porosity. For example, E-bars of aluminium/11 per cent. magnesium alloy cast into soft-rammed moulds exhibit much more layer porosity and have lower tensile-properties than the same metal cast into hard-rammed moulds; the difference in soundness and strength are attributable to the greater chilling power of the hard-rammed sand.

(7) Little or no layer porosity occurs in gassy or unfed test-bars of aluminium/4.5 per cent. copper alloy and the amount of porosity resulting from lack of feeding is much less than in test-bars of aluminium/10 per cent. magnesium alloys. As a result, test-bars in aluminium/4.5 per cent. copper alloys containing gas or shrinkage porosity have considerably higher tensile-properties than similar bars of the magnesium alloy.

(8) The average magnesium-content of a D.T.D. test-bar of L.53 alloy is about 0.9 per cent. greater than that of the melt from which it is cast, owing to the flow of magnesium-rich liquid from the feeder. It is probable that similar segregation occurs in commercial castings, the compositons of which may therefore differ substantially from that of the analysis sample and the nominal composition of the melt. This variation in composition makes it difficult to obtain a sample for analysis, representative of the melt, from many test castings; in the present work, a moderately-chilled wedge-shaped casting which was sampled by sawing vertically through the centre was found to be the most satisfactory.

It should be noted that the D.T.D. test-bar, used here because of its sensitivity to gas, usually has lower mechanical properties than the "E" bar which is more generally employed in production control. However, a recent survey of results obtained from "E" bars cast from production melts, shows a very similar correlation between magnesium content and tensile properties[19]. In the present work, no observations have been made on the influence of magnesium content on proof stress, fatigue properties or resistance to stress corrosion.

EXPERIMENTAL DETAILS

Materials

The material used was commercial ingot to B.S.1490-LM10, diluted when required with commercial-purity aluminium or magnesium ingot. The compositions of ingot material, hardeners and addition elements are shown in Table II. The beryllium and titanium hardeners were made com-

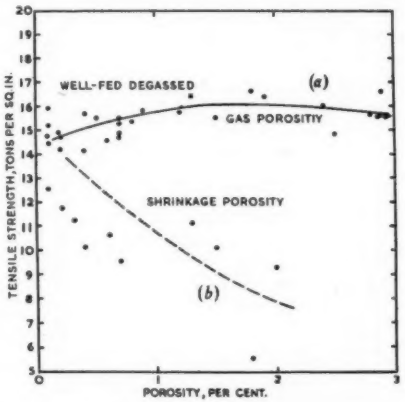


FIG. 4.—*Effect of gas- and shrinkage porosity on the tensile strength of* 1 *in. dia. test-bars containing* 9.0 *to* 9.95 *per cent. magnesium.*

mercially; the boron hardeners were made by diluting a commercial 25 per cent. alloy in molten aluminium, under a cryolite flux cover, at 1,200 deg. C.

TABLE II.—*Composition of Ingot Material Used (per cent.)*

Alloying element.	B.S. 1490. LM10 Ingot.		Al/B Hardener.		Al/Ti Hardener.	Al/Be Hardener.	Commercial-purity Mg.	Commercial-purity Al.
	(*a*)	(*b*)	(*a*)	(*b*)				
Copper	tr.	tr.	tr.	tr.	0.09	tr.	—	—
Silicon	0.09	0.12	0.10	0.08	0.15	0.1	—	0.1
Iron	0.18	0.21	0.40	0.01	0.33	0.1	—	0.13
Magnesium	10.58	10.4	—	tr.	0.01	3.0	99.8	—
Aluminium	bal.	bal.	bal.	bal.	bal.	bal.	—	bal.
Boron	—	—	0.3	0.32	—	—	—	—
Titanium	tr.	tr.	tr.	<0.002	2.5	—	—	0.002
Beryllium	—	—	—	—	—	5	—	—

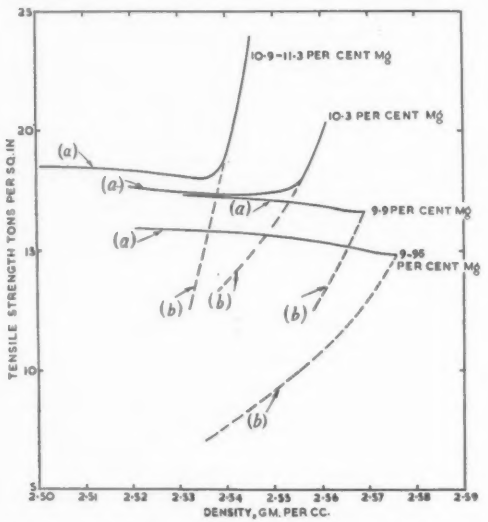


FIG. 5.—*Influence of magnesium content, shrinkage- and gas-porosity on the tensile strength of 1 in. dia. sand-cast test-bars of aluminium/magnesium alloys.*

Key: (*a*) well-fed bars containing gas-porosity, (*b*) bars containing shrinkage-porosity, cast from degassed melts.

Melting and Casting

Alloys containing 9 to 14 per cent. magnesium were prepared in melts of 15 to 18 kg.; titanium (0.01 per cent.) and boron (0.005 per cent.) were added for grain refinement and beryllium (0.005 per cent.) to suppress metal/mould reaction. All melts were made in Salamander crucibles heated in a gas-fired injector furnace and were degassed (when required) by flushing with nitrogen bubbled through carbon tetrachloride. This method of degassing was chosen as it required no flux, and thus facilitated the use of a hand ladle. Freedom from dissolved gas was checked by solidification of a small sample under reduced pressure[7].

In most of the work 1-in. dia. D.T.D. test-bars were used but some larger (1½-in. and 4-in. dia.) castings were made to study the effect of section-thickness and E-bars were cast in experiments on the effect of mould hardness. All moulds were made in a synthetic sand, bonded with 5 per cent. bentonite and containing 2 per cent. boric acid; they were dried before use and, except the E-bars, were inclined at the beginning of casting. The pouring time for a complete D.T.D. test-bar was 8 to 12 seconds. Pouring temperatures were between 680 and 720 deg. C.

Some 1-in. dia. test-bars were deliberately made containing gas or shrinkage porosity, as follow:—(*i*) Gas porosity: while the melt was being degassed, metal was removed at intervals in a hand-ladle and a series of fully-fed D.T.D. test-bars of decreasing gas-content was cast; (*ii*) shrinkage porosity: test-bars with incompletely-filled feeder-heads were poured from degassed melts; the height of the feeders controlled the amount of shrinkage porosity so that a series of bars with a range of densities was obtained; (*iii*) some test-bars were made containing both types of porosity by pouring partly-fed bars from incompletely-degassed melts.

Solution Treatment

The 1-in. and 1½-in. dia. bars were heat-treated in a forced-air-circulation furnace for 16 hours at 425 or 430 deg. C.; 6-in. by 1-in. sq. specimens cut

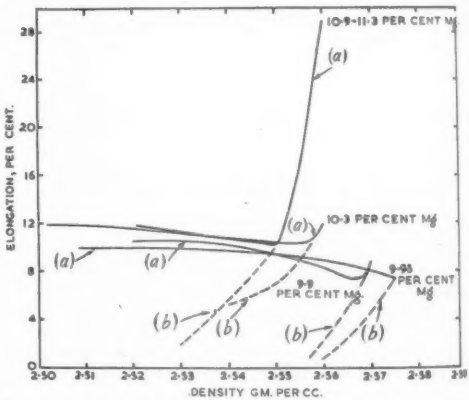


FIG. 6.—*Influence of magnesium content, shrinkage- and gas-porosity on the elongation of 1 in. dia. sand-cast test-bars of aluminium/magnesium alloys.*

Key: (*a*) well-fed bars containing gas-porosity, (*b*) bars containing shrinkage-porosity, cast from degassed melts.

from the 4-in. dia. bars were solution-treated for 16, 24, 40 and 48 hours at 425 or 430 deg. C. All bars were quenched in oil at room temperature.

Composition and Properties of Test-bars

Considerable variation in composition has been observed both within a single casting of aluminium/10 per cent. magnesium alloy and from one casting to another made from the same melt. This variation, which is due to the differences in feeding of magnesium-rich liquid, is discussed in the Appendix

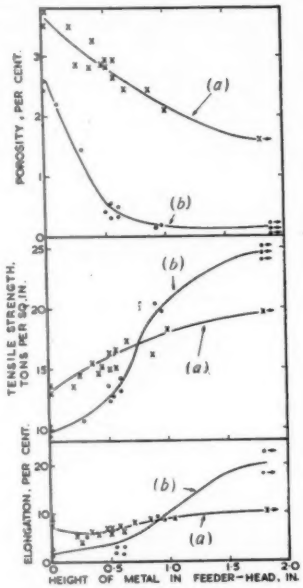


FIG. 7.—*Effect of dissolved gas on the porosity and tensile properties of incompletely-fed 1 in. dia. test-bars of Al/11 to 12 per cent. Mg.*

Key: (*a*) bars cast from gassy melts, (*b*) bars cast from degassed melts.

where the methods of selecting analysis-samples and the differences in the magnesium content of these samples are also described. In particular, the magnesium contents of the test-bars were 0.9 per cent. higher than those of the melts from which they were cast.

The compositions quoted in the main part of this Paper are those of 1-in. dia. test-bars, as from these magnesium contents, the maximum densities of the alloys could be deduced for the calculation of porosity; the relation between the magnesium content and the maximum density is shown in Fig. 1 which is based on previous work[1].*

The porosity in the as-cast test-bars was calculated from their measured densities and the densities of the fully-sound alloys from Fig. 1. The type and distribution of porosity were examined in longitudinal sections through portions of the bars adjacent to the tensile test-pieces. Tensile strength and elongation were determined from 0.564-in. dia. test-pieces machined from the bars.

RESULTS AND COMMENTS

Tensile Properties

(1) *Bars of 1-in. dia.*

The tensile properties of well-fed D.T.D. bars cast from degassed melts increased sharply with magnesium content, reaching a maximum at about 11 per cent. magnesium (Fig. 2); above 12.2 per cent. the tensile properties fell again because of incomplete solution of the beta phase during heat-treatment (see later). Other workers have published a curve[4] (Fig. 2) showing a similar effect of magnesium content in ½-in. dia. bars, but Parker, Cox and Turner[5] concluded that tensile properties were only slightly dependent on magnesium content of the melt in the range 9.5 to 11 per cent.

The effect of gas content on well-fed bars depended on their composition. At a high magnesium-content, the presence of slight gas-porosity resulted in a sharp fall in tensile strength from 24 to 18 tons per sq. in. as shown in Fig. 3 (full line, (*a*)),

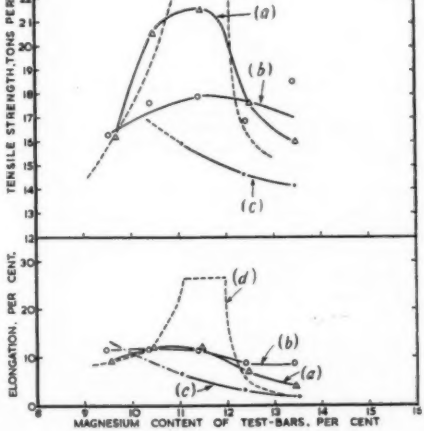


FIG. 8.—*Influence of magnesium content on the tensile strength and elongation of 1½ and 4 in. dia. test-bars poured from degassed melts.*

Key: (*a*) 1½-in. dia. bars heat-treated for 16 hrs. at 430 deg. C.; (*b*) centres of 4-in. dia. bars heat-treated for 16-48 hrs. at 430 deg. C.; (*c*) centres of 4-in. dia. bars heat-treated for 16 hrs. at 425 deg. C. The broken line (*d*) is superimposed from Fig. 2 for 1-in. dia. bars.

but even with higher gas-porosities (0.5 to 3 per cent.) the tensile strength seldom fell below 18 tons per sq. in. In contrast, the bars of a low magnesium-content (9 to 10 per cent.) all had low

* The maximum densities quoted in the previous work were those of as-cast, directionally solidified cylinders made in a sand sleeve on a chill block; in order to obtain the corresponding densities of sand-cast D.T.D. bars, from which Fig. 1 was constructed, a slight correction was made (plus 0.005 gm. per cc.) to allow for the smaller amount of β-phase in the slowly-cooled sand castings. This correction was deduced from the difference in the changes in density which occurred when chill-cast and sand-cast samples were completely solution treated. Possible errors in Fig. 1 due to incorrect sampling for magnesium analyses in the previous work are discussed in the Appendix.

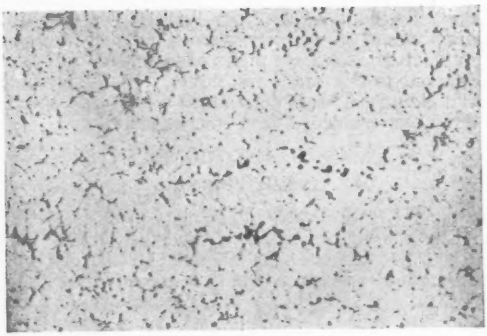


FIG. 9.—*Layer-porosity typical of well-fed, gas-free D.T.D. bars of about* 10 *per cent. magnesium, or slightly-gassy bars of higher magnesium-content. (Tensile strength approximately* 19 *tons per sq. in.)* × 25.

tensile-properties irrespective of gas content, an increase in gas content having, if anything, a slightly-beneficial effect (see Fig. 4, full line). The effect of gas content, assessed by density measurement, on both tensile strength and elongation is shown in Figs 5 and 6 (full lines) for several magnesium-contents. The maximum theoretical-density of these alloys decreases as the magnesium content is raised (see Fig. 1), and in every alloy in Figs. 5 and 6 the highest density obtained corresponds to low gas-porosity (0.1 or 0.2 per cent.).

Shrinkage porosity had a markedly deleterious effect on the tensile properties of all bars irrespective of magnesium content, the properties falling very sharply with even slight shrinkage-porosity (see Figs. 4 and 5, broken lines). The effect of porosity at several magnesium-contents, on both tensile strength and elongation is shown in Figs. 5 and 6 (broken lines).

The effect of gas porosity in incompletely-fed bars is illustrated in Fig. 7 where the tensile properties and porosities of 1-in. dia. test-bars containing 11 to 12 per cent. magnesium are plotted against the height of metal in the feeder-heads. In bars which had more than 0.4 per cent. shrinkage voids when cast from degassed metal, the addition of gas produced an improvement in tensile properties even though the porosity was greatly increased. This demonstrates that although well-fed test-bars cast from gassy melts may have low tensile-properties, castings from these melts which cannot be adequately fed may be superior to those from degassed alloys. A similar use of dissolved gas is of course commonly made in the control of hot-tears, shrinkage and surface draws in die-casting practice.

(2) *Bars of* 1½*-in. and* 4*-in. dia.*

The magnesium content had a similar, though smaller, effect on the tensile strength of test-pieces from the 1½-in. dia. bars, as shown in Fig. 8, but its influence on the elongation of these specimens was small.

Neither tensile strength nor elongation of specimens from the 4-in. dia. bars, however, was much affected by the magnesium content (Fig. 8). In these castings, mould reaction could not be completely suppressed and all test-pieces from near the surface, therefore, had poor tensile strengths and elongation—less than 16 tons per sq. in. and 7 per cent. respectively. Test-pieces from the sounder metal near the centre, had higher properties when adequately solution-treated but required longer times, or higher temperatures, than the 1-in. dia. bars; solution was far from complete after 16 hours at 425 deg. C. but an increase in temperature to 430 deg. C. produced an improvement, longer times at this temperature having no further effect on properties.

Grain Sizes and Microstructures

The grain sizes of all the test-bars were between 0.15 and 0.3 mm. dia. and there was no regular variation with magnesium content or porosity which could explain the variation in tensile properties.

The undissolved beta-phase in D.T.D. test-bars heat-treated for 16 hours at 425 deg. C. was present only in traces at 11.2 per cent. magnesium, but in much larger quantities at 12.5 and, particularly, 13.5 per cent. magnesium. The incomplete solution of the brittle beta-phase accounts for the low tensile properties of the 1-in. dia. bars containing more than 12.2 per cent. magnesium; the aluminium/magnesium equilibrium diagram indicates that better properties would probably have been obtained if a longer time or higher temperature had been used in solution treatment of these bars.

In the 4-in. dia. bars which had been heat-treated at 425 deg. C. for 16 hours, the amount of undissolved beta-constituent was greater than in the corresponding 1-in. dia. bars, and was quite large even at 11.3 per cent. magnesium; solution was more complete at 430 deg. C. The slow response

FIG. 10.—*Layer-porosity typical of well-fed D.T.D. bars of less than* 10 *per cent. magnesium, or partially-unfed bars of* 9 *to* 14 *per cent. magnesium. (Tensile strength* 15 *to* 17 *tons per sq. in.)* × 5.

of the large bars to heat-treatment was, no doubt, caused by the coarse distribution of the β-phase due to the slow rate of solidification.

Porosity

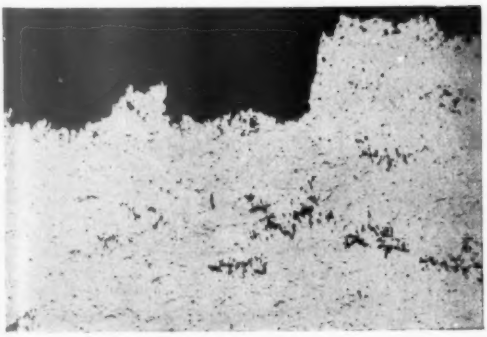
(1) *Bars of* 1-*in. dia.*

In the well-fed bars poured from degassed melts, the individual voids were much smaller than the primary dendrites and occurred mainly at the grain boundaries; in the bars containing more than 10.5 per cent. magnesium, these small, intergranular voids were uniformly distributed over the cross-section, but in bars of lower magnesium-content they tended to concentrate in shallow layers perpendicular to the axis, particularly when the bars contained 9.5 per cent. or less magnesium. Typical examples of layer-porosity in slight and severe forms are shown, respectively, in Figs. 9 and 10; a section through a tensile test-piece, Fig. 11, showed that the fracture passed through the layers of porosity and confirmed that these were responsible for the fall in tensile properties with decreasing magnesium-content shown in Fig. 2.

Whatever the magnesium-content of the test-bar, when feeding was restricted the voids became more sharply concentrated in layers (see Fig. 12), thus producing the marked reduction in tensile properties shown, for example, in Figs. 3 and 4 (broken lines). Even a slight increase in total shrinkage-porosity to 0.4 per cent. had a large effect on tensile properties.

Small quantities of gas in the well-fed bars of high magnesium-content produced similar, but less intense, layer-porosity, coinciding with the sharp fall in tensile strength from between 22 and 24 to 18 tons per sq. in. (Fig. 3, full lines); greater gas contents resulted in pinhole porosity, but there was no further drop in tensile properties even with the gross pinhole-porosity shown in Fig. 13. When the magnesium-content was reduced so that layer-porosity appeared even in bars from degassed melts, dissolved gas produced few additional layers before the appearance of pinholes; similarly, gas did not add to the already severe layer-porosity in poorly-fed bars but, if sufficient gas was present,

FIG. 11.—*Section through fracture in test-piece of* 9.2 *per cent. magnesium.* × 5.



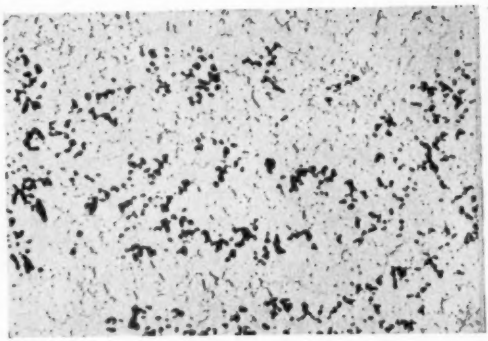


FIG. 12.—*Intense layer-porosity of poorly-fed gas-free D.T.D. bars containing* 9 *to* 14 *per cent. magnesium. (Tensile strength less than* 10 *tons per sq. in.)* × 25.

some layers tended to thicken into gross pinhole-porosity.

(2) *Bars of* 1½- *and* 4-*in. dia.*

The structures of the 1½-in. dia. bars were very similar to those of the 1-in. dia. bars cast from degassed melts, though the lower elongations suggest that traces of layer-porosity were present in the 1½-in. dia. bars even at high magnesium-contents.

Sections of the 4-in. dia. bars, however, contained considerable porosity, corresponding to the high percentages (2.2 to 3.6 per cent.) calculated from the densities. Much of this porosity was probably due to gas formed by mould reaction at the casting surface, rather than to lack of feeding; perhaps owing to this, the voids were only slightly concentrated in layers and resembled gas-porosity rather than shrinkage in the smaller bars. It is probable that an increase in the rate of cooling by the use of chills would greatly reduce the porosity of large castings, both by improving feeding and restricting mould-reaction; thus, the tensile properties would be made to approach those of the D.T.D. bar. For these reasons it may be desirable to chill heavy sections in this alloy as a matter of routine.

Influence of Mould Hardness

The tensile properties obtained from E-bars cast into soft- and hard-rammed sand are shown in Table III. It is evident from these figures that the mould hardness influences the tensile properties of E-bars cast in inhibited sand. Micro-examination of longitudinal sections from some of the bars

TABLE III.—*Influence of Mould Hardness on Tensile Properties of E-bars in Aluminium/11 per cent. Magnesium Cast into Soft- and Hard-rammed Moulds.*

Mould hardness Diertert No.	Tensile strength, tons per sq. in.		Elongation, per cent.	
	Range (12 bars)	Average	Range (12 bars)	Average
90 to 100 ..	18.2 to 24.1	22	9 to 23	16
40 to 50 ..	16.0 to 20.2	18	6 to 12	9

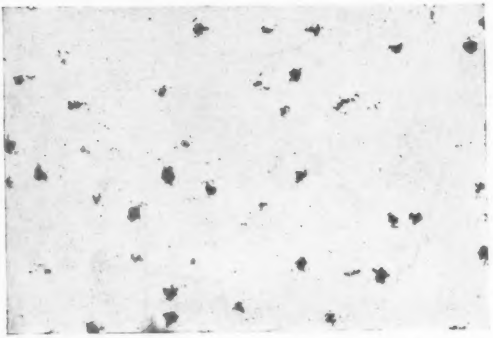


FIG. 13.—*Gross pinhole-porosity in well-fed but gassy D.T.D. bars of* 11 *to* 12 *per cent. magnesium.* (*Tensile strength approximately* 18 *tons per sq. in.*) × 5.

showed the presence of fairly severe layer-porosity in bars cast in soft moulds (Fig. 14), whereas bars from hard moulds showed little layer-porosity (Fig. 15).

A recent report[5] confirms that in a hard-rammed mould the risk of mould-reaction is considerably reduced and attributes this to the higher thermal-conductivity of the hard mould, which reduces the freezing time. However, the effect would not be expected to alter the nature of any porosity present and it seems likely in the present case that the harder mould with the greater chilling power has given more favourable temperature-gradients for feeding the centre of the bar at the expense of the feeders. If this view is correct, hard ramming could conceivably have precisely the opposite effect, or none at all, on the incidence of layer porosity in poorly-fed castings and in castings of another section-thickness, and the results of the limited tests reported here merely illustrate how the tensile properties of the alloy are sensitive to minor variations in casting conditions.

Comment on Results

The variation in tensile properties can thus largely be explained by the influence of magnesium content, gas content and degree of feeding on the formation of layer porosity. As would be expected, this distribution of microporosity has a far worse effect on tensile properties (measured perpendicularly to the layers) than either scattered microporosity or much larger amounts of pinhole porosity; work on other alloys has shown that pressure-tightness would be similarly affected by layer porosity.

It is clear from the above results that D.T.D. test-bars containing less than 10 per cent. magnesium are unlikely to meet the specified tensile-properties (B.S. L53); the optimum properties are obtained when the test-bars contain about 10.6 to 12 per cent. magnesium.

Occurrence and Cause of Layer-porosity

Layer porosity of the type described above, has been observed in the same alloy by Parker, Cox and Turner[3] but its variation with magnesium content or with the amount of porosity was not studied; other workers have described a similar distribution of porosity in cast magnesium/aluminium alloys[7, 9] both magnesium-rich and aluminium-rich, and in fine-grained bronzes and gunmetals[12]. All these alloys have long freezing-ranges and solidify in a pasty manner; several of them are also prone to mould reaction, but layer porosity is observed even when this reaction is substantially inhibited by additions to the melts or to the moulding sand. The mechanism of the formation of layer porosity which is suggested below is based on that put forward by Baker[7].

The first stage of solidification in an alloy which freezes in a pasty manner consists in the movement of liquid metal together with small dendrites floating in the melt; this has been termed mass-feeding[7]. As the dendrites grow, they gradually interlock and eventually form a semi-coherent network. Work on aluminium-alloys by Singer and Cottrell[13] and later workers[17, 18] suggests that this occurs when as much as half of the metal is still liquid.

As the temperature continues to fall, the feeding of pasty metal towards the parts of the casting remote from the feeder, becomes impeded to an increasing extent by the stiffness of the network and by the restraining influence of metal near the surface, which, being cooler than the interior, is also firmer. Shrinkage due to continuing solidification and to the contraction of the dendrites as they cool now begins to impose tensile stresses on the network which, as long as any liquid persists, remains brittle[15, 17, 18] and therefore tears perpendicularly to the temperature gradient (*i.e.* to the stresses). An

FIG. 14.—*Section of fracture of bar cast in soft mould* (*hardness No.* 50)*; showing layer-porosity.* (*Tensile strength* 18 *tons per sq. in.*) ×6.

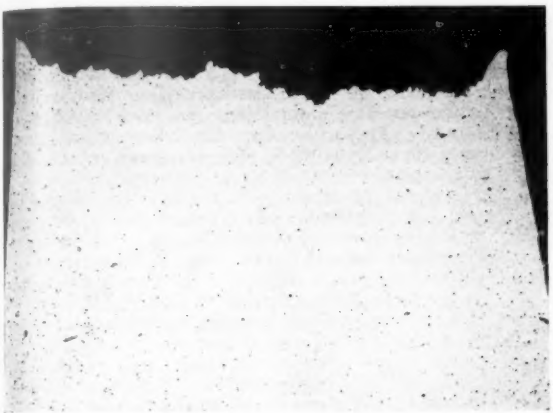


FIG. 15.—*Section of fracture of bar cast in hard mould (hardness No. 100); no layer-porosity. (Tensile strength 24 tons per sq. in.)* ×6.

external restraint imposed by the mould on the contracting network produces hot-tears in a similar way[10, 13, 14, 17]. At first, the tears are healed by the flow of residual liquid through the interstices of the network but this type of feeding becomes increasingly difficult as the dendrite-arms thicken, with the result that many of the tears may be incompletely filled. Layers of porosity are thus formed. In some alloys (for example, aluminium/11 to 12 per cent. magnesium) the fissures are produced only when the action of the contraction stresses is assisted, or healing prevented, in the ways described below.

At whatever stage of solidification the layers of porosity appear, they would be formed (if the above theory is correct) from partially-liquid metal and would be healed by residual melt rich in impurities. This was confirmed in the present work by the rounded shape of the individual voids (shown in Fig. 9) and by the fact that the impurity constituents, Mg_2Si and $FeAl_3$, were often concentrated in bands continuous with layer porosity. The last feature was observed only in fully-fed bars cast from degassed melts; when gas or shrinkage porosity was present, the residual liquid had presumably been more completely withdrawn into the dendrites. Layer porosity produced by shrinkage or dissolved gas in magnesium-base alloys was observed by Baker[7] to be associated with impoverishment in eutectic liquid.

The improvement resulting from an increase in magnesium content in degassed aluminium/magnesium alloys can be ascribed to the increase in the volume of the eutectic liquid. As pointed out above, the network of dendrites becomes coherent when the proportion of residual liquid falls to about one half; the larger the volume of the eutectic, the lower is the temperature at which this cohesion occurs and hence the smaller is the temperature range in which the brittle network is subjected to contraction stresses; moreover, any fissures which are formed are more effectively healed, the larger the volume of the eutectic liquid[10]. Thus the severity of layer porosity is reduced by an increase in magnesium content; this effect is similar to the greater resistance to hot-tearing imparted by an increase in magnesium content in these alloys.[15, 16]

The formation of layer-porosity would also be influenced by other factors. Its formation would be opposed by hydrostatic and externally-applied pressure which, by overcoming the rigidity of the dendrite network, would assist mass-feeding. An improvement in tensile properties resulting from solidification under pressure in an autoclave has been described by Parker *et al*[8]. Hydrostatic pressure is probably the cause of the low concentration of layer-porosity at the bottom of the vertically-cast D.T.D. test-bar (the fracture usually occurs near the top in tensile tests) compared with the uniform distribution along the axis of the horizontal E-bar; this difference may be enhanced by the greater segregation of magnesium which has been shown to occur in the D.T.D. bar.[9]

On the other hand, the production of internal fissures would be assisted by the release of moderate amounts of dissolved gas from solution or by lack of feeding. The influence of inadequate feeding and dissolved gas has been confirmed by the results described above. With high gas-contents, the gas would begin to come out of solution at an early stage of solidification, thus forming pinholes instead of increasing the severity of layer porosity, and would tend to thicken the individual layers, as described earlier. In a recent paper[11] it has been shown that visible microporosity can be eliminated by the degree of degassing achieved by boiling the

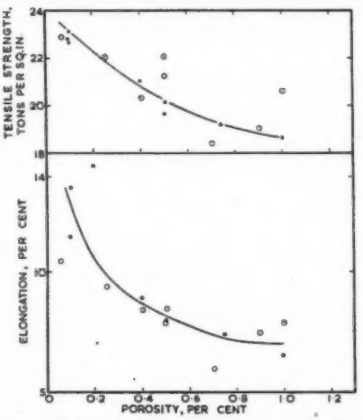


FIG. 16.—*Effect of dissolved gas- and shrinkage-porosity on the tensile strength and elongation of 1 in. dia. test-bars of Al/4½ per cent. Cu.*

Key: ● fully-fed bars cast from gassy melt, ○ incompletely fed bars cast from degassed melt.

melt under reduced pressure, mass-feeding and capillary-flow then proceeding almost to completion; however, the merest traces of gas were found to prevent complete feeding and, in the present work, attempts to eliminate layer-porosity by more effective degassing met with no success.

The influence of gas derived from mould reaction may also be considerable; particularly extensive layer-porosity has been observed, for example, in fine-grain gunmetals in which mould reaction occurred[12]. To determine whether traces of gas

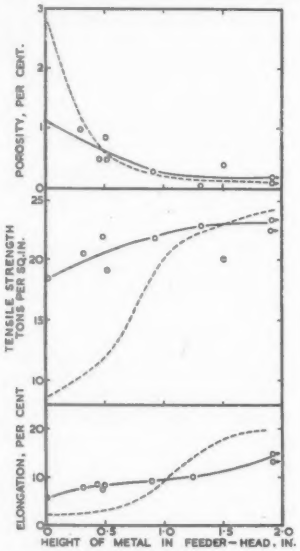


FIG. 17.—*Effect of incomplete feeding on the porosity and tensile properties of Al/4.5 per cent. Cu in 1 in. dia. test-bars cast from degassed metal.*

Key: broken line, Al-11 to 12 per cent. Mg. alloy, and solid line, Al/4.5 per cent. Cu alloy.

due to this reaction have any influence on the formation of layer porosity in well-fed aluminium/9 per cent. magnesium alloy, a series of D.T.D. test-bars were cast into silliminite moulds and into moulds lined with heated steel shells, in which the metal had little opportunity of reacting with moisture. The tensile properties of the bars were found to be similar to the properties of the 9 per cent. magnesium alloys quoted above. It was concluded, therefore, that layer porosity in the beryllium-containing test-bars cast in sand inhibited with boric acid was not due to mould reaction to any important extent.

Comparison of Fine- and Coarse-grain Alloys

An important advantage of grain-refinement in the aluminium/magnesium alloys is that intergranular porosity generally becomes more finely divided and more uniformly distributed[3]. It has been shown above, however, that in some circumstances, particularly when feeding is restricted, the intergranular voids in fine-grain castings concentrate in shallow layers which might be even more harmful than the elongated grain-boundary voids in coarse-grain alloys. A comparison was therefore made of the properties of fine- and coarse-grain test-bars containing gas- and shrinkage-porosity, to see whether the coarse-grain alloys were superior to those with fine-grain under some conditions.

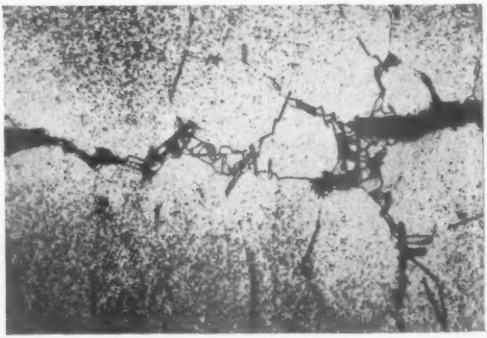
A series of coarse-grain test-bars containing 11 per cent. magnesium was prepared by omitting the grain refiners and casting at 750 deg. C.; the average grain diameter was 3 mm. The large intergranular voids in the poorly fed and in the gassy bars tended to lie perpendicular to the direction of solidification, as in the fine-grain alloys, but the coarse-grain bars were generally twice as porous as the corresponding fine-grain castings for a given size of feeder. The tensile properties of the coarse-grain bars were correspondingly low, generally only 60 per cent. of the properties of the fine-grain castings. Even when layer-porosity was present, therefore, fine-grain castings were stronger than those with coarse-grain.

Comparison of Aluminium/10 per cent. Magnesium with Aluminium/4.5 per cent. Copper Alloys

To determine whether the tensile properties of the alternative high-strength casting alloy, aluminium/4.5 per cent. copper alloy, were similarly affected by gas- or shrinkage-porosity, series of fine-grain bars were cast with a range of porosities in the ways described above. These were solution-treated for 16 hours at 535 deg. C., quenched in water, and aged for 16 hours at 140 deg. C.

Porosity, whether due to gas or shrinkage, was fairly-uniformly distributed in the bars, the tendency to form layer-porosity being very slight; this confirmed previous observations on this alloy[7]. The fall in tensile properties with increasing porosity was correspondingly smaller than in the 11 per cent. magnesium-alloy, as shown by comparison of Figs. 3 and 16; gas- and shrinkage-porosity produced very similar effects.

FIG. 18.—*Section through tensile test-piece of incompletely solution-treated Al/5 per cent. Cu alloy showing incipient cracks in the layer of undissolved ternary-eutectic.* (*Etched in* 0.5 *per cent. HF.*) × 250.



It was also observed that when the size of the feeder-heads was restricted, the increase in porosity was much smaller in the aluminium/copper bars than in the magnesium-containing alloys; in bars with small feeder-heads, the aluminium/copper alloy therefore had much higher properties, not only because of the absence of layer-porosity but also because of the smaller volume of porosity. This effect is shown in Fig. 17 in which porosity and tensile properties are plotted against the height of the feeder-heads, the corresponding curves for the aluminium/magnesium alloys being included for comparison.

The absence of layer-porosity from the aluminium/4.5 per cent. copper alloy cast into simple test-bar moulds appears, at first sight, to be contrary to the known tendency of this alloy to form hot-tears in moulds which resist the contraction of the casting.[15 16] This apparent contradiction may perhaps be ascribed to the smaller influence of the healing process on the formation of hot-tears in the latter type of mould; such tears are exposed to atmospheric pressure and are therefore refilled or closed only with difficulty, whereas the smaller, internal tears in a test-bar are not exposed to atmospheric pressure and are therefore readily healed by mass feeding or interdendritic flow. If this suggestion is correct, the difference between aluminium/copper and aluminium/magnesium alloys when cast into test-bar moulds may be accounted for by a greater capacity of the former for healing hot-tears. Some evidence of healing by interdendritic flow was observed in test-bars of an aluminium/copper alloy, in which layers of the iron-rich ternary eutectic lay at right angles to the thermal gradient, as illustrated in Fig. 18. Furthermore, the fact that only 1 per cent. porosity was present in 1-in. dia. bars of aluminium/copper alloy cast without a feeder-head, compared with 2½ per cent. in the aluminium/magnesium alloys (see Fig. 17), indicates that mass-feeding also is more efficient in the copper alloy.

It is difficult to explain, however, why feeding (*i.e.*, healing of tears) should be more efficient in aluminium/copper than in aluminium/magnesium alloys. Properties such as the shape and deformability of the solid-solution dendrites and the viscosity and mode of solidification of the residual eutectic liquid would influence feeding, but there is no evidence that the two alloys differ greatly in these properties.

APPENDIX

Magnesium Contents of Test-bars and Composition of Test Castings

It has been reported that a considerable variation in composition occurs throughout a casting of aluminium/10 per cent. magnesium alloy,[4] the difference in magnesium content between the top and bottom of a DTD bar, for example, being as much as 0.7 per cent.

This variation created a difficulty in the present work because, in order to calculate the porosity of a test-bar, it was first necessary to deduce its maximum density from the magnesium content. It was found, however, that consistently-low porosities were obtained for well-fed, gas-free bars of 1-in. dia. by taking the magnesium content of a sample from near the middle of each bar, adjacent to the fracture after tensile-testing; the compositions of these samples have therefore been taken as the average compositions of the test-bars in the results described above. If the magnesium contents determined in this or previous[1] work were in error by as much as 0.5 per cent., owing to imperfect sampling, the corresponding error in the calculated porosities would be only 0.2 per cent.

A further difficulty was that the average compositions of the test-bars were different from those of the melts from which they had been poured, as the bars had been fed with magnesium-rich liquid from their feeder-heads; a separate test-piece for the determination of the melt composition had therefore to be cast. Since feeding occurs to some extent in all castings, a sample representative of the melt can be obtained only: (*i*) by using an entire test-casting as the sample for analysis, *e.g.* a bead prepared by granulation (without oxidation), or (*ii*) by sawing completely through a test-casting (including the feeder) of uniform cross-section, in the direction of the temperature gradient during solidification.

The correct position from which to take a sample of even a simple casting by the second method is seldom clear: for example, in a bar cast horizontally in an open chill-mould—a common form of analysis sample—feeding occurs not only from top to bottom but also from the last-poured end to the first-poured, owing to temperature gradients set up during pouring; similarly, a slow rate of cooling in such a casting produces temperature gradients between the middle and ends of the bar, owing to more rapid cooling at the ends.

To obtain information on the variation in magnesium content to be expected with the aluminium/10 per cent. magnesium alloy, the following test castings were made from several melts: (*i*) a heavily-chilled wedge-sample in an uncoated copper mould; (*ii*) a lightly-chilled wedge-sample in an alumina-coated iron mould; (*iii*) a ¼-in. dia. pencil in an iron mould, such as is used for spectrographic analysis; and (*iv*) a well-fed D.T.D. bar. In the last three cases, the metal was poured rapidly into one end of the mould but the sample cast into the copper mould solidified so rapidly that it was found necessary to move the crucible from one end of the mould to the other during pouring. The sample for analysis was obtained in each case by sawing completely through the middle of each test-sample.

The magnesium content varied considerably from one type of casting to another. From all melts the lowest figure was obtained from the lightly-chilled sample made in the coated iron mould, in which longitudinal temperature-gradients formed during pouring and solidification were evidently the smallest; these magnesium contents, and deviations of the other analyses from these figures, are given in Table IV. Comparison of the average deviations shows that segregation was as marked in the copper-chilled wedge as in that of the well-fed spectrographic pencil; the greatest deviation—0.9 per cent.—was observed with the D.T.D. bars.

It is common practice in industry to use a severely-chilled bar as an analysis sample; from the results shown in Table III it is evident that the magnesium content of a sample taken through an unfed, lightly-chilled bar is more representative of the melt; it is, of course, possible that even this sample was not sufficiently accurate and further investigation of the sampling of melts for analysis is required, particularly in view of the variation of tensile properties with composition reported above.

TABLE IV.—*Analytical Deviations of Magnesium Contents (Per Cent.).*

Melt No.	Magnesium content of sample cast in coated iron mould.	Deviation from magnesium content of sample cast in coated iron mould.		
		Gas-free D.T.D. bar.	Spectro pencil.	Copper wedge.
1	9.6	+ 0.7	+ 0.5	+ 0.6
2	10.3	+ 1.1	+ 0.5	—
3	10.4	+ 1.0	+ 0.9	+ 0.8
4	10.9	+ 0.7	+ 0.3	—
5	10.9	+ 1.2	+ 0.5	+ 0.8
6	11.0	+ 0.9	+ 0.5	—
Average	—	+ 0.9	+ 0.5	+ 0.7

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Thermal Conductivity of Iron

The thermal conductivity of grey iron is a property that often deserves greater consideration than it receives from designers and engineers. As noted below, such conductivity may be of critical importance, and grey iron cannot always be replaced satisfactorily by other materials that have greater strength, but lower thermal conductivity. Indeed, grey iron's ability to conduct heat may, in some cases, be a more important factor to consider than its lack of strength. In their paper before the Gray Iron Division of the American Foundrymen's Society, J. A. Davies, H. W. Deem, and H. W. Lownie, Jr, of the Battelle Institute, have listed situations in which thermal conductivity may be a significant factor to consider. These situations are where :—

(1) The flow of heat is unsteady or cyclic; thus one face of a coating may be alternately heated and cooled, as on the hot face of the pistons in a two-cycle engine.

(2) Metal sections are thick, as in the water-cooled rolls used to form glass.

(3) There is rapid transfer of heat to the iron or away from the iron, as when the surface of a brake drum is heated by friction.

(4) There is a fairly large difference in temperature between the hot and cold faces of the casting.

Thermal conductivity may also have an important effect on the performance of equipment in certain applications, as when it is desired to: (*a*) transfer heat through the iron so as to do a job on the cooler side of the casting wall; and (*b*) transfer heat through the iron so as to get it away from a hot face. Thus in the first case, lower conductivity may result in less heat where it is needed. In the second type of application, failure to get heat away fast enough may increase tendencies for the heated face of a casting to warp, heat check, oxidize, or grow.

BERRY'S FOUNDRY (1949), LIMITED, have removed to Hammerton Street, Bradford, 3.

Ship Orders Steady

The flow of shipbuilding orders to British yards was maintained in the second quarter of this year, according to the latest returns. There are indications that most yards have enough work on hand to keep them busy until 1960, but this in itself points to one of the industry's greatest problems—longer delivery dates than those offered by overseas competitors. It is apparent, too, that steel supply difficulties and the shortage of labour are far from being overcome.

Sixty-nine ships, amounting to 436,000 gross tons, were ordered from British yards in the second quarter of this year, bringing the total for the first half of 1956 to 142 ships of an aggregate gross tonnage of 752,000, which compares with 520,000 tons in the corresponding period of last year. Tanker orders continue to predominate, comprising about 43 per cent. of the total in the first six months of this year. Export orders formed approximately 38 per cent. of the tonnage in the period. The total shipbuilding order-book comprises 797 ships totalling 5,240,000 tons, over 1,000,000 tons more than a year ago and only a shade lower than at the end of the first quarter. The value of this tonnage has been put at £675,000,000.

Last week it was announced that contracts believed to be worth over £5,500,000 had been awarded to the Furness Shipbuilding Company, Limited, Haverton Hill-on-Tees. They comprise two oil tankers of 24,750 tons d.w. each for Bermudan owners and two dry-cargo vessels, each of 15,900 tons d.w., for Panama. From Norway an order for a 19,600-ton d.w. oil tanker has been placed with Barclay Curle & Company, Limited, Glasgow. The contract is worth about £750,000.

BRITISH VACUUM CLEANER & ENGINEERING COMPANY, LIMITED—Mr. R. C. Robson, who has been appointed a director, will continue to act as secretary.

THE SITE formerly occupied by the Coltness Iron Company, Limited, at Wishaw (Lanarkshire) is to become the Scottish headquarters of the Reich Drill Manufacturing Company, of Indiana, USA.

Surface Defects in Some Sand-cast Stainless Steels

By Brian H. C. Waters, Carl Hayward† and Howard F. Taylor‡*

After outlining the aims of the research and the mode of occurrence of the "measles" defect, the Authors discuss test-bars, metal and moulds selected for their experiments. Next are listed observations on appearance of castings resulting from various mould treatments. The promising effect of using aluminium paint was given extended trial both on a laboratory and works scale and results are reported. Finally, a theory is put forward which would seem to explain several aspects of the measles defect and provide an explanation of the success of the preventive methods developed.

Introduction

The aim of the work to be described was to prevent the "measles" defect in stainless-steel alloys of the CA 15 type when cast in a green-sand mould. This alloy corresponds to British Standard Specification 1630 Grade A casting steel. The defect is shown in the untreated casting of Fig. 1. It has been termed the "measles" defect because it gives a pitted appearance on the surface of an otherwise sound casting. A similar defect occurs in alloys of this type made by precision casting[1], where it is suggested that the defect may be due to incomplete mould firing, retained organic materials derived from the expendable pattern being responsible.

Evidence available at the start of this work indicated that:—

(*a*) The measles defect only occurred in CA 15-type steel alloys, *i.e.* in alloys with a composition: C, 0.15; P, 0.04; Ni, 1.00; Mn, 1.00; S, 0.04, and Si, 1.5, all maximum per cent., with Cr, 11.5 to 14.0 per cent.

(*b*) The measles defect was encountered when these alloys were cast in green-sand moulds, but not when they were cast in dry-sand moulds.

Because of this second piece of evidence, it was considered that the most promising line of attack to cure the "measles," was to replace the mould atmosphere by one that was reducing (or at any rate less oxidizing than wet air) during the casting process. From this work, an aluminium paint spray treatment was developed for this steel which will: (*a*) Inhibit measles formation, making the defect smaller and less deep than usual; (*b*) strengthen the sand surface of a green-sand mould, thus minimizing danger of mould erosion, and (*c*) reduce or eliminate cold shuts in metal poured colder than usual.

Experimental Work

The experimental treatment of this problem was essentially practical, in that the aim was to cure the measles defect by making castings and treating moulds under conditions as typical of shop practice as possible. Such theories as did evolve concerning the cause of the defect were a by-product of the research. The method adopted was to cast CA 15 alloy in green-sand moulds, using the standard A.C.I. (Alloy Casting Institute of America) pattern shown in Fig. 2. This design was chosen by a committee of A.C.I. as one likely to produce surface defects in high-alloy castings. Moulds were normally made of sand of composition given in Table I, although facing sands of special composition were sometimes used. High-frequency melting was used. No difference in the incidence of the defect was found as between metal produced from virgin metal and scrap charges.

TABLE I.—*Moulding Sand used in the Investigation.*

	Experimental work.		Foundry X.		Foundry Y.	
	AFS Fineness No.	Per cent.	AFS Fineness No.	Per cent.	AFS Fineness No.	Per cent.
New silica sand ..	80	20	60	92.0	70	15.5
Old returned sand	80	76	—	—	70	78.5
Western bentonite	—	5	—	3.5	—	1.7
Dextrine	—	1	—	0.5	—	0.3
Cereal	—	3	—	1.0	—	—
Moisture	—	—	—	3.0	—	4.0

Preliminary Trials

After some mould treatments were found promising, work was undertaken on a plant scale with co-operating member firms of A.C.I. to establish the feasibility of using the method developed for curing the measles on production castings.

Various approaches were adopted to the problem: (1) Investigation of the effect of casting temperature on the incidence of the defect; (2) use of skin-dried facing sand; (3) use of phenol-formaldehyde shell-moulding resin, mixed with the facing sand; (4) (*a*) use of aluminium paint brushed on as a mould dressing, and (*b*) use of aluminium as a mould spray; (5) use of organic materials as sprays and as admixtures to sand, and (6) use of inorganic materials as direct mould additives.

Naturally, it often happened that two variables

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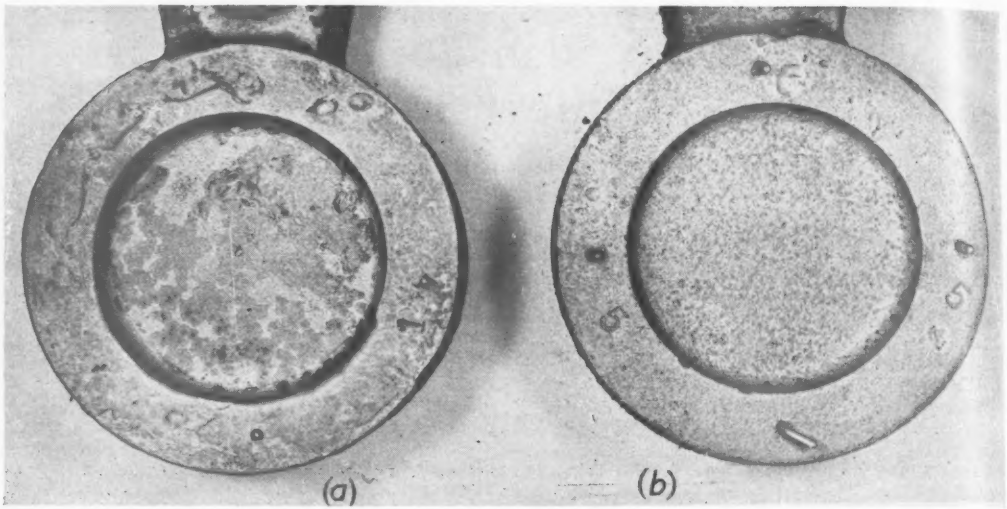

FIG. 1.—*The casting (a), treated with aluminium paint, shows better definition and considerable reduction in cold shuts and "measles." The untreated casting (b) was made in a mould sprayed with a wash and skin dried. (Reproduction approximately ½ full size.)*

Supplementary data: Foundry K; alloy type CA 15: Casting Information: metal composition: C 0.119, Mn 0.62, P 0.18, S 0.020, Si 0.62, Cr 12.50, Mo 0.10, Ni 0.29, Cu 0.11, and Al 0.02 per cent.; sand practice: composition of mould wash—182 qts. silica flour. 56 qts. Delco paste, 2 qts. Western bentonite, 126 qts. water; furnace practice: Arc.

were present. For instance, when aluminium paint was used, it was not at first certain whether the flake aluminium or the paint vehicle, which was organic in nature, was affecting results. Therefore separate tests were done for each.

Effect of Casting Temperature

Castings were made in green-sand moulds to investigate the effect of casting temperature on the measles defect and the results are shown in Table II. It was found that, when castings were poured either very hot or very cold, the tendency to measles formation was less than if the castings were poured at an intermediate temperature. Unfortunately, this "intermediate" casting temperature was considered by many foundries to be the optimum casting temperature from most points of view. If castings are poured very hot, other difficulties, such as metal penetration, mould erosion, and possibly gas porosity, are liable to arise. On the other hand, if castings are poured cold, then cold shuts and mis-runs are likely. For these reasons, an "intermediate" casting temperature was used for most of this experimental work.

TABLE II.—*Effect of Casting Temperature on Incidence of "Measles" Defect in Alloy C.A. 15.*

Tapping temperature, deg. C.	Measles severity.
1,650	↑
1,620	Decreasing.
1,560	
1,538	Maximum severity.
1,527	
1,516	
1,506	
1,493	Decreasing.
1,485	
1,460	↓

Dried Facing Sand

Since CA 15 alloy did not show measles defect when cast in a dry-sand mould, it was decided to test the effect of drying the mould surface. One obvious way of doing this was by direct flame drying and the results of a series of castings made in moulds so treated is shown in Table III. Moulds dried for periods up to 15 min. were dried with a smoky acetylene torch; those dried for 24 hrs. were

TABLE III.—*Effect of Drying of Green-sand Moulds on Incidence of the Measles Defect.*

Drying time,* min.	Measles severity.
1	B.
2	B.
	A.
	C.
	C.
4	C.
	C.
	B.
5	A.
	A.
10	A.
15	A.
24 hrs	A.
	A.

* Moulds dried for periods of up to 15 min. were dried with a smoky acetylene torch; the others were oven dried.

oven dried. Ratings are from A to C, a rating of A indicating castings which were free from measles.

It will be seen that results are somewhat erratic: castings flame-dried for five minutes or more gave a good casting surface free from measles. Flame drying gave a dry surface about $\frac{1}{4}$ in. deep and a fine carbon deposit was left on the mould surface. This may have assisted in elimination of measles by providing a reducing environment at the mould surface.

It was evident from this work that flame drying had two disadvantages: (1) The drying took too long—a period of five-minutes drying on a mould surface about 126 sq. in. area is uneconomical; (2) the dry surface sand was in a weakened condition, so that its resistance to erosion was decreased. Tests were therefore made in which the

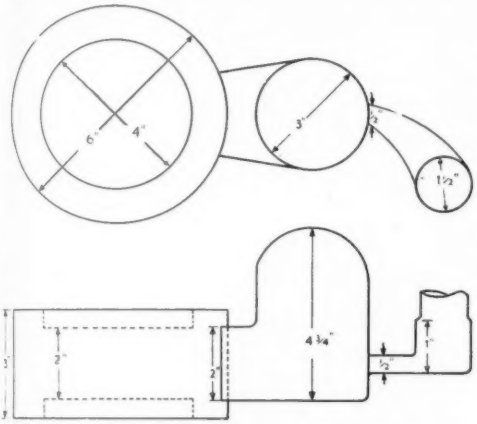

FIG. 2.—*Standard design of test-bar developed by the Alloy Casting Institute, of America.*

mould was coated with an inflammable material. A proprietary liquid was used, having a benzene-type base in which is dissolved a rubber-like substance, which gives increased bonding to the sand grains and decreased erosion as compared with flame drying. The solute also has the effect of inhibiting migration of moisture to the surface. Various coatings of the dressing were applied varying from light to very heavy; the coating was in each case being ignited after application. Although less erosion was encountered, this treatment did not cure measles. Presumably, the drying resulting from simple ignition of the spray was inadequate.

Moulds were also dried by allowing them to stand in air before pouring. On standing for three hours, the measles defect was only a little reduced, though it was noticeably reduced when the moulds were allowed to stand for 24 hrs. However, this practice weakened the sand and caused sand erosion troubles, and it was the general opinion of most foundries consulted that to dry moulds in this way would be impracticable for most of their work. Therefore, no intensive study was made of air drying as a measles preventive.

Shell-moulding Resin

Shell-moulding resin was applied at the mould face, since it was thought that this resin might seal off the mould cavity and also provide reducing decomposition products when the mould was poured. It was applied in several ways, in some cases it was mixed with facing sand (sometimes also with the addition of carbon black), while in others it was used as a spray; the resin being dissolved in an alcohol solvent to which benzene or xylene was generally added. These additives were made chiefly so that the solvent could subsequently be burned. The results obtained are shown in Tables IV and V. Solid shell-moulding resin was also added in a bag placed in the blind riser, $\frac{1}{4}$ oz. being used in a similar way to the application of material when it is desired to increase the pressure on casting[2]. However, this casting exploded slightly on pouring, showing that the resin cannot safely be used undiluted in this way.

TABLE IV.—*Effect of Adding Shell-moulding Resin to Facing Sands on the Incidence of the Measles Defect.*

Resin, per cent.	Secondary addition.	Measles severity.
3	—	B B
3	3 per cent. lamp black ..	B B
5	3 per cent. lamp black ..	B B

The tests in which shell-moulding resin was added to the facing sand showed that the resin was capable of giving a marked improvement in the

TABLE V.—*Effect on the Measles Defect of Applying Shell-moulding Resin in a Solvent to Green-sand Moulds. (Resin in a solvent vehicle was applied by spraying).*

Coating thickness*	Solvent.†	Drying method.	Measles severity.	Remarks.
Light	(a)	Ignite	A	Cope porosity.
Medium	(a)	Ignite	A	
Medium	(a)	Ignite	A	Cope porosity, scabbing.
Heavy	(a)	Ignite	A	Cope porosity.
Medium	(a)	Infra red lamp ..	C	
Medium	(a)	Infra red lamp ..	C	
Medium	(b)	Ignite	A	
Heavy	(b)	Ignite	A	Cope porosity, scabbing.
Medium	(c)	Ignite	A	Cope porosity
Heavy	(c)	Ignite	A	
Medium	(d)	Ignite	A	
Heavy	(d)	Ignite	A	

* A "heavy" coat corresponds to approximately 2 ml. per sq. in.; a "medium" coat to 0.75 ml. per sq. in.; and a "light" coat to 0.25 ml. per sq. in.

† Solvents: (a)= methyl alcohol; (b)= 70 per cent. methyl alcohol and 30 per cent. benzene; (c)= 50/50 methyl alcohol and benzene; (d)= 20 per cent. methyl alcohol and 80 per cent. benzene. Approximately 10 per cent. solutions of resin were used.

measles condition. It also gave a smoother casting finish, generally, but in two cases scabbing took place. This was probably due to uneven burning of the resin, producing unevenly hardened areas of mould. Also, cope porosity was often found, this being probably caused by localized heavy concentrations of resin, possibly coupled with inadequate burning of the solvent used. It has now been shown that shell-moulding resins give considerable gas evolution[3], and in a green-sand mould the gases cannot escape as readily as they can from a shell mould. For these reasons, although the use of shell-moulding resins is interesting because they seem capable of producing a hard, smooth mould surface (similar to a shell mould) their use cannot be recommended in current practice and at this stage on the basis of this present work.

Aluminium Paint

Aluminium paint used as a mould treatment was originally considered to be of interest because aluminium metal is capable of reducing chromic oxide (Cr_2O_3) at the casting temperatures used for CA 15 alloy (about 1,560 deg. C.). Much of the work for this investigation was concentrated on aluminium paint as a mould wash or spray.

Aluminium reacts with both iron oxide and chromic oxide to give an exothermic reaction which reduces both of these oxides to their respective elements. The first reaction is:

$$2Al + Fe_2O_3 = Al_2O_3 + 2Fe \quad . \quad . \quad . \quad . \quad (1)$$

The other reaction, which is exothermic to a lower degree, and which will take place only after all the iron oxide has been reduced to its elements is:

$$2Al + Cr_2O_3 = Al_2O_3 + 2Cr \quad . \quad . \quad . \quad . \quad (2)$$

This reaction is therefore potentially able to reduce any chromic oxide which may form on the surface of a casting.

The exothermic deoxidizing reaction is not, however, the only effect which may be achieved by use of aluminium paint. The aluminium paint may, by its sealing effect due to polymerization of its vehicle, and by the leafing action of the aluminium flake, succeed in inhibiting migration of water vapour from the backing sand to the casting surface. In this way, a less-oxidizing atmosphere may be produced at the casting surface.

A further effect may be that the aluminium paint reflects back the heat from the metal entering the mould, reducing heat absorbed by the sand. The emissivity of aluminium (0.05 c.g.s.) is only one-eighth that of sand (0.4 c.g.s.). This effect is not believed to have any direct bearing on the occurrence of "measles," but it probably plays a part in minimizing cold shuts and reducing spalling from mould walls. Cold shuts are also probably reduced by the exothermic nature of the aluminium and metal-oxide reaction, the two effects combining to produce markedly different surfaces on castings poured cold, with and without aluminium paint. The mould sprayed with aluminum paint gave a better and sharper casting. This effect was most marked on the test castings poured by member foundries, and is reported in more detail in the section of this Paper dealing with this phase of the investigation.

Because it seemed that aluminium paint might have uses, not merely in eliminating the "measles" defect in CA 15, but also, more generally, in reducing cold shuts, an extensive investigation of the use of aluminium paint as a mould dressing was made. The results are reported in Table VI. It will be

TABLE VI.—*Effect of Aluminium Paint on the Surface of CA. 15 Castings Made in Green-sand Moulds.*

Treatment used.*	Measles severity.	Remarks.
Paint A	A	Some gas in casting.
Paint A	A	—
Paint A and flame dry	A	—
Paint A and flame dry	A	—
Paint A and flame dry	A	—
Paint A, medium coat; air dry 24 hrs.	A	—
Paint A, medium coat; air dry 24 hrs.	A	—
Paint A heavy coat; air dry 24 hrs.	A	—
Heavy coat paint; air dry 24 hrs.	A	Mould blow out.
Heavy coat paint; air dry 24 hrs.	A	—
Flame dry	B	—
Old sand; flame dry	B	—
Old sand; flame dry	B	—
New facing sand; flame dry	B	—
Green-sand mould; new facing sand	B	—
Green-sand mould; new facing sand	B	—
Green-sand mould; new facing sand	B	—
New facing sand, flame dry	B	—
New facing sand, flame dry	B	—
Old sand; sprayed; flame dry	B	—
Spray Al paint, S8211	A	Mould dried for 2 hours. Then flame dried. Mould vented. Burning gas emitted from vents.
Spray Al paint, S8200	A	
Spray Al paint, S8503	A	
Spray Al paint, S8210	A	
Spray Al paint, S8300	A	
Spray Al paint, S852	A	
Spray Al paint, S8456	A	
Spray Al paint, A	A	
Spray Al paint, S8503	A	Mould dried for 2 hours. Then flame dried. Mould vented. Did not blow. Burning gas emitted from vent.
Spray Al paint, S8300	A	
Spray Al paint, S8210	A	
Spray Al paint, S852	A	
Spray Al paint, S8456	A	
Spray Al paint, S8200	A	
Spray Al paint, A	A	
Old sand; air dry 3 hrs.	B	—
Old sand; air dry 3 hrs.	B	—
Old sand; air dry 3 hrs.	B	—
Old sand; air dry 3 hrs.	B	—
Old sand; air dry 3 hrs.	B	—
Old sand; sprayed Al paint, S8503; flame dry; wooden pattern	B	Test No. 130.
Old sand; sprayed Al paint S8503; flame dry; wooden pattern	B	—
As 130, but Al pattern used	B	—
As 130, but new facing sand	B	—
As 130, but Al pattern used	B	Test No. 133.
As 133, but only lightly flame dried	B	Surface porosity.
New facing sand	B	Test No. 3X.
As 3X	B	—
New facing sand; green-sand mould; air dry 5 days	B	—
New facing sand; flame dried	B	—
New facing sand; flame dried	B	—
New facing sand; flame dried	B	—
New facing sand; two coats Al paint and flame dried	B	—
New facing sand; flame dried	B	—
New facing sand	C	—
Old sand; heavy coat of Al paint; flame dried	B	—
Old sand; light coat of Al paint; flame dried	B	—

* All moulds made in green-sand and covered with aluminium-paint spray immediately after being made, and prior to subsequent treatment.

seen that, in nearly all cases, an aluminium-paint mould dressing gave improved casting surface. Sometimes the measles defect was virtually eliminated, at other times it was much reduced. In general, this reduction took the form of reduction of area and depth of individual spots as compared with untreated castings. In addition the important effect of a marked reduction of cold shuts was obtained with an aluminium dressing.

Procedure Developed

The procedure developed on the basis of this work, which was used in all works trials, was as follows:

1. Paint was sprayed directly on the mould surface, the thickness of the coat being determined as in normal painting procedure; the surface being completely covered, but with the thickness of the coat not so great as to inhibit normal drying.
2. The painted surface was flame dried to burn out the volatile paint vehicle. The painted surface was considered to be sufficiently dry when it no longer ignited when the flame was held over it. Care was taken to move the flame rapidly over the surface so that no portion of the surface became blackened.
3. Care was taken that all moulds were adequately vented.

In a further series of tests, flake-aluminium powder was mixed with the facing sand in several percentages (5, 10, 15 and 20 per cent.), the results being shown in Table VII. These castings showed freedom from measles, but other defects, such as burn-on, were encountered and these precluded the use of aluminium in this way.

To further confirm the beneficial effect of aluminium paint, castings were made in which only part of the mould was coated. These castings showed freedom from measles only at those points where the aluminium paint was applied and the untreated parts of the mould showed measles in plentiful amounts. A typical casting is shown in Fig. 3. It was thought that the paint vehicle might play a part in the action of the paint by sealing the mould cavity from moisture, or by providing a reducing atmosphere at the mould face. For this reason a range of organic liquids of similar type to the paint vehicle, were tried as mould dressings, both with and without pre-ignition. Alcohols, oils, resins and rubber-type compounds were all tried. But, with the exception of the shell-moulding resins already referred to, none of these treatments gave any improvement in casting surface.

The use of an aluminium paint spray was the only really promising mould-treatment developed in the test work; results were considered sufficiently encouraging for an extensive investigation by member foundries in plant practice. Visits were made to two steel foundries by members of the M.I.T. investigating team, and castings were made under their supervision in moulds prepared by spraying with aluminium paint. Other member foundries prepared and sent castings, some made when using their regular production techniques for

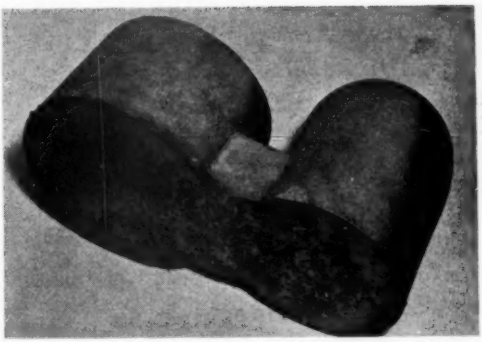

FIG. 3.—*Specimen casting in alloy CA 15, weighing 102 lb., produced from a sand mould sprayed with aluminium paint on the cope surface only. The drag part, only, produced the measles defect.*

castings of this type, and some made using aluminium paint as a mould dressing, paint having been sent to each member foundry with detailed directions for its use. The results from this industrial field investigation are given later.

Aluminium as Mould Additive

Since mould spraying may be somewhat costly and is a nuisance for snap-flask moulding, tests were made in which solid aluminium was piled loosely in the mould cavity. In some tests, aluminium wire was used, and in others, the aluminium was in the form of foil or powder. It was realized this method of adding aluminium would contaminate the metal more than use of the mould spray, but tests were made primarily for research information. The results are reported in Table VII and Table VIII. The metal was poured

TABLE VII.—*Effect on the Casting Surface of Additions of Powdered Aluminium to the Facing Sand.*

Al Powder used in facing sand, per cent.	Measles severity.	Surface burn on.
5	A	Medium.
10	A	Heavy.
15	A	Heavy.
20	A	Heavy.

at about 1,560 deg. C., the normal casting temperature. It will be seen that the aluminium wire was incompletely melted, so that it acted as a chill. This chill then lowered the temperature of the metal poured below the critical range at which measles can occur. Thus measles were not formed, though cold shuts were. When small amounts of aluminium foil were added to the metal in the mould the foil went into solution, but the measles defect was not prevented.

Use of Other Materials as Mould Additives

Since a major consideration was to provide an inert mould atmosphere during the casting process,

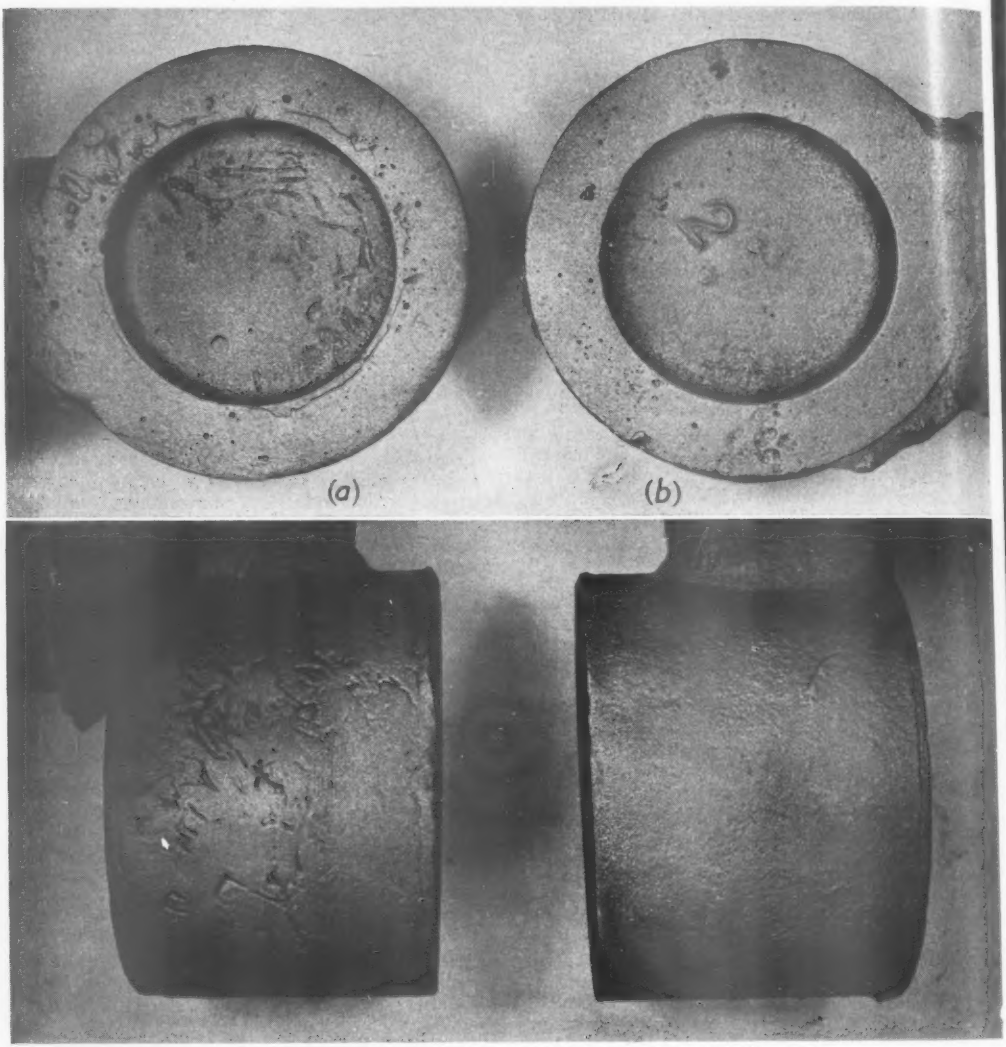

FIG. 4.—*Castings* (*a*) *untreated and* (*b*) *treated, produced in alloy CA* 15 *by Foundry X, under supervision of M.I.T. personnel.* (*Approximately* ⅓ *full size.*)

a variety of other mould additives which seemed capable of doing this were tried; these tests and results are shown in Table IX.

Coal-dust was first used. It evolves volatile hydrocarbons under the influence of heat, and the remanent carbon is a reducing agent. However, coal-dust did not prevent measles formation, and its use affected the moulding properties of the sand adversely when used in large amounts.

Calcium carbide, which reacts with moisture in the sand giving acetylene:

$$CaC_2 + 2H_2O = C_2H_2 + Ca(OH)_2$$

was also tried. It was thought this might produce a reducing atmosphere in the mould even before the mould was heated. No worthwhile effect was found, however, and reaction of carbide with the moisture in the sand while it was being rammed, made moulding difficult.

Ferrous sulphate was also tried. The object in using this was to produce a reducing ferrous oxide and an inert sulphur-trioxide gas, *viz:*

$$FeSO_4 = FeO + SO_3$$

It was, however, realized that these were not the only possible reactions, and that other reactions,

TABLE VIII.—*Effect of Solid Aluminium Additions to the Mould Cavity on the Incidence of the Measles Defect.*

Agent used.	Measles severity.	Remarks.
Old sand; ½ oz. Al wire in cavity	A	Al wire incompletely fused.
Old sand; ¼ oz. Al wire in cavity	A	,, ,, ,,
Old sand; ½ oz. Al wire in cavity	A	,, ,, ,,
Old sand; ¼ oz. Al wire in cavity; ¼ oz. Al wire in riser	A	,, ,, ,,
Old sand; ⅝ oz. Al wire in mould cavity	A	,, ,, ,,
Old sand; ⅜ oz. Al wire in cavity, ⅜ oz. Al wire in riser	A	,, ,, ,,
New facing sand; green-sand mould; Al foil, size 12 by 4 in., placed at bottom of sprue	C	
As previous, but foil size 12 by 8 in. used	C	
New facing sand; green-sand mould; bag containing ⅛ oz. Al powder placed at bottom of sprue	B	

some of which might even be oxidizing, could possibly take place. The $FeSO_4$ was applied as an additive in the facing sand and also dusted on the mould surface as a powder. This latter method of application was inefficient, but in no case did use of this material appreciably reduce the measles defect.

For obtaining technical information only, higher oxidizing conditions were deliberately tried. Manganese dioxide and sodium nitrate were either added to the facing sand or sprayed in suspension or solution. The results from this limited series of experiments were only mildly encouraging. When these treatments were used, the measles were reduced enough to be classified as slight, but it was obvious that auxiliary objections to use of such oxidizing conditions would preclude use of the method in practice.

Risotherm, an exothermic compound, was used as a mould additive. The aim was to generate heat in the mould to force water-vapour away from the casting surface by expansion of the gas contained in the mould. The results using this material were not at all promising and no useful technical information was obtained.

Castings Made by Member Foundries

Since M.I.T. work with aluminium sprays showed promise, work was undertaken in conjunction with member firms of the A.C.I., some firms providing facilities for test castings to be made at their works under supervision of M.I.T. research staff. Other firms made test castings, both with and without an aluminium-paint mould-dressing, and sent them to M.I.T. for examination and comparison with castings similarly produced by different member firms.

The first foundry visited (designated Foundry X) used a facing sand on all its castings, of the composition given in Table I; moulds were rammed to a hardness of only 70. Standard test castings were made, and poured at a series of temperatures, the results obtained being given in Table X, and treated and untreated castings, poured at 1,570 deg. C., are illustrated in Fig. 4. It may be remarked that worm-hole porosity occurred in all these castings, both treated and untreated, possibly due to gassy metal. It is of interest that the untreated castings showed measles when cast at higher temperatures than those which gave measles in the laboratory investigation. It was observed in this foundry that castings of heavier section (of about 2-in. and over) were more prone to the development of the measles defect than castings of lighter section.

The second foundry visited was one where much of the production was made by snap-flask moulding. An all-purpose sand was used, no facing sand being

TABLE IX.—*Effect of Various Materials on the Incidence of the Measles Defect.*

Addition used.	Method of applying.	Aim of addition	Measles severity.	Remarks.
3 per cent. Coal-dust	In facing sand	Reduce pO_2	C	Coal dust interferred with moulding properties of sand.
1 per cent. Calcium carbide	,,	Reduce pO_2 give C_2H_2 atmosphere	C	Very poor moulding properties
3 per cent. Ferrous sulphate	,,	Reduce pO_2 by SO_2 formation	C	
Ferrous sulphate	Dusted on surface	,,	C	Inefficient application.
,, ,,	,,	,,	C	
,, ,,	,,	,,	B	
New facing sand, with 10 per cent. manganese dioxide added		Increase pO_2	B	
New facing sand; green-sand mould; drag dusted with manganese dioxide	Dusted on	,,	B	
New facing sand; green-sand mould; surface sprayed with heavy coat of manganese dioxide and then flame dried.	Spray	,,	B	Test No. 200.
As 200	,,	,,	B	
New facing sand; green-sand mould surface sprayed with solution of sodium nitrate in water and flame dried	,,	,,	B	
Risotherm	In mould cavity	Heat generation to force away water from mould face	C	

Surface Defects in Some Sand-cast Stainless Steels

TABLE X.—*Effect of Casting Temperature on the Casting Surface.*

Casting temperature, deg. C.	Measles.		Lapping.	
	Treated.	Untreated.	Treated.	Untreated.
1,570	B	A	A	C
1,593	B	A	A	C
1,658	A	C	A	A

employed, the composition of the sand being given in Table I. As is usual when this type of sand is used, the water content of the sand at the mould surface is somewhat higher than that usually encountered when a facing sand is used. In fact, the water content actually recorded is low for an all-purpose sand to be used in snap-flask moulding; the mould hardness was 70 to 80.

In using the paint spray on a snap-flask moulding line, the moulder set the two halves of the mould down on the roller table instead of closing them as is usual. A second operator then sprayed the moulds with paint, burnt off the paint "vehicle," closed the mould, and returned the jackets to the moulding operator. Thus an extra set of jackets was used as compared with normal operations.

At this foundry, several moulds were treated with aluminium paint, and compared with untreated moulds. In each case the use of the paint made the measles defect smaller and shallower, while there was a noticeable freedom from cold lapping in the castings made in treated moulds.

Mechanism of "Measles" Formation

Because this research was not conducted with the aim of inquiring into the mechanism of measles formation, only a tentative theory was developed to explain the phenomenon. The main conclusions emerging from the work were as follow.

(1) The "measles" defect only occurs in CA 15 alloy.

(2) The defect is due to a reaction at the casting surface, and is not due to the entrapment of slag, etc.

(3) The defect is associated with the formation of an adherent, blackish deposit in the "measles" pits, the rest of the casting surface having a greenish tinge.

(4) The defect is reduced by casting either at high or low temperatures.

(5) Aluminium paint, applied as a leafing spray to the mould wall before casting, greatly diminishes the defect. It also reduces or eliminates cold shuts in metal poured colder than usual.

(6) The defect is found only in CA 15 alloy cast in green-sand moulds: if the alloy is cast in dry-sand moulds, it is not encountered.

(7) There is evidence that reducing atmosphere in the mould during casting helps reduce the "measles" defect.

In studying the chromium/oxygen equilibrium in liquid iron, Chen & Chipman[4] have shown that chromite ($FeO\ Cr_2O_3$) is the stable solid phase for iron/chromium alloy melts containing low chromium (about 2 per cent.), while chromic oxide (Cr_2O_3) is the stable solid phase for high-chromium (about 15 per cent.) melts. The transition from melts with which chromite is stable to those with which chromic oxide is stable occurs at from 5 to 7 per cent. chromium. This, however, is only true when exact equilibrium is obtained between the oxygen in the metal and the stable non-metallic phase: when excess oxygen is present both chromic oxide and chromite may be formed, and presumably this latter condition represents what occurs in practice. Areas of chromite form on the casting surface, and the rate of formation of the chromite is different from the rate of formation of the chromic oxide which covers the rest of the casting surface. Thus pits are formed by a mechanism similar to that proposed in classical corrosion theory.

Such a general theory is in harmony with the effects obtained, although no definite proof has been obtained. Thus, a mechanism such as that suggested might well account for the effect being influenced by casting temperature, and reduced by the presence of an aluminium mould dressing, by a reducing mould atmosphere or by a dry-sand mould. All the last three factors would reduce the excess oxygen available in the metal.

Acknowledgments

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[2] C. W. Briggs and H. F. Taylor, *Proc. I.B.F.*, 1953, **46**, A207.
[3] B.H. C. Waters, FOUNDRY TRADE JOURNAL, 1955, **98**, 587.
[4] H. M. Chen and J. Chipman, *Trans.* Amer. Soc. Metals, 1947, **38**, 70.

Iron and Steel Import Duties

Under the Import Duties (Exemptions) (No. 11) Order, 1955, import duties on a wide range of iron and steel products are suspended until September 18, 1956, while those on certain cold rolled sheet are suspended until March 18, 1957. After consultation with the Iron and Steel Board about the supply position, the Government has decided to make a new Order which, with one exception, prolongs the suspension of import duty for a further six months on those products on which duty has hitherto been suspended until September 18, 1956. The one exception is galvanized sheet, upon which the duty will be restored after September 18.

The Government has obtained undertakings from the main consumers of tinplate that all available home-produced tinplate, including the full output from the hand-mills, will be taken up while the duty on tinplate and tinned sheet remains suspended.

The new Order, the Import Duties (Exemptions) (No. 8) Order, 1956 (SI 1097), will come into operation on September 19, 1956. Copies of the Order may be obtained from the Stationery Office, price 3d.

Steel Production Lower

Although steel production in June exceeded that of June, 1955, output was lower than in earlier months of this year, the fall being mainly due to the ban on overtime by maintenance workers. Production in that month was at the rate of 379,700 tons a week, against an average of 412,700 tons a week in the preceding five months of the year.

In June, 1955, production was at the rate of 364,200 tons a week, output then being adversely affected by the railway strike. The loss of production through the overtime ban in the second quarter of this year is estimated to have reached 300,000 tons.

Latest Output Returns

The following table gives the latest steel and pig-iron output figures (in tons) and compares them with earlier returns:—

Period.	Pig-iron.		Steel ingots and castings.	
	Weekly average.	Annual rate.	Weekly average.	Annual rate.
1956—April ..	254,300	13,225,000	421,100	21,896,000
May ..	246,500	12,820,000	396,400	20,612,000
June ..	239,600	12,459,000	379,700	19,744,000
Half year ..	254,500	13,232,000	407,600	21,196,000
1955—April ..	238,500	12,401,000	393,300	20,455,000
May ..	241,800	12,574,000	401,600	20,884,000
June ..	216,800	11,274,000	364,200	18,939,000
Half year ..	235,400	12,242,000	387,500	20,149,000

Steel production quarter by quarter from the beginning of 1954 is shown in the following table:—

	1954.	1955.	1956.
1st quarter	4,694,000	5,074,000	5,413,000
2nd quarter	4,830,000	5,001,000	5,185,000
3rd quarter	4,216,000	4,547,000	—
4th quarter	4,779,000	5,169,000	—
	18,519,000	19,791,000	—

The Iron and Steel Board states that the demand for steel remains high, particularly in the case of plates, joists, and heavy sections, which are mainly required for shipbuilding and constructional engineering. Lighter products, including cold-rolled strip and wire rods, are in less demand, as are sheets for some durable consumer goods. The change in relative emphasis from consumer goods to capital construction and exports which was noted two months ago shows every sign of persisting.

Raw material supplies in the first half of this year were adequate. Stocks of iron ore are being built up following a reduction of supplies in the earlier months of the year when ore imports were lower than planned because severe weather in the Baltic reduced supplies from Sweden and political difficulties affected supplies from French North Africa.

Stocks of raw materials at the end of June were:—Imported ore, 1,461,000 tons (1,035,000 tons at June 30, 1955); pig-iron 847,000 (579,000) tons; scrap, 750,000 (561,000) tons.

TYNE AND WEAR SHIPYARDS begun their annual holidays on Monday. Half of the yards on the Tyne will be closed for two weeks from that date, and the other half will start their break a week later. On the Wear, all the yards will be closed down at the same time.

Labour Restive in 1955

The Annual Report of the Ministry of Labour refers to the "restlessness" of labour in 1955, and points out that the number of working days lost through industrial disputes—3,781,000, compared with 2,457,000 in 1954—was the highest since the war. Claims for increased wages were made in most industries, says the Report, but in the main they were settled in a constitutional way within the industries. The rise in the average level of weekly wage rates was greater than in the year before and "again outstripped the increase in retail prices as measured by the interim index."

The general picture was of an industrial economy stretched to its utmost which, with no reserves of labour to call on, was seeking on the one hand to heighten production by increased mechanization and the redeployment of labour, and on the other hand to maintain industrial peace through better co-operation and understanding at all levels and through improved methods of personnel management.

The unemployment figures in July, 1955, were the lowest on record since the war. In May, 1955, there were 55,000 workers on a short week (this May there were 100,000). Last November 1,820,000 men and women were doing overtime (this May there were only 1,540,000).

Fires in Industry

The sixth conference of the British Occupational Hygiene Society is to be held at the London School of Hygiene and Tropical Medicine on November 12 at 10.30 a.m. The conference will be opened by H.M. Chief Inspector of Factories, Sir George Barnett, and the following papers will be read:—"A Technical Survey of Fire in Industry," by N. C. Strother Smith, M.A., A.M.I.E.E. (director, Fire Protection Association); "Industrial Fires from the Point of View of the Fire Brigades," by E. R. Ashill, A.M.I.F.E. (chief officer, Croydon Fire Brigade); "First-aid for Casualties from Fire," by D. McG. Jackson, M.D., F.R.C.S. (surgeon-in-charge, M.R.C. Burns Unit); "Modern Methods of Fire Alarm and Extinction," by P. Nash (Fire Research Station), and "Managerial Responsibilities and Fire Prevention," by H. Mason Bibby, M.ENG., M.I.MECH.E. The conference fee for persons who are not members of the society is one guinea; applications should be sent to the hon. scientific secretary, Dr. D. Turner, M.R.C. Laboratories, Holly Hill, Hampstead, London, N.W.3.

Russian Machine-tool Orders

Mr. V. E. Skobstov, a member of the board of the Soviet Ministry of Machine Construction, said on July 20 that the section of the trade delegation to Britain which he heads was ready to recommend the purchase of automatic machine tools from Sentinel (Shrewsbury), Limited, and would like to place orders as soon as possible. The delegation was visiting the Sentinel works for the third time in a month.

Mr. Skobstov said the amount of machinery to be purchased would not be known until the head of the delegation, Mr. Malychev, had conferred with Mr. Peter Thorneycroft, President of the Board of Trade. He added that Russia was prepared to spend between £27,000,000 and £36,000,000 on about 500 special machines made in Britain.

Law Cases

Lords Dismiss Power Tariffs Appeal

In a reserved judgment the House of Lords dismissed an appeal by the South of Scotland Electricity Board and the Central Electricity Authority over certain proposed charges for the supply of high-voltage electricity to the British Oxygen Company, Limited, at its Hillington works, Glasgow. The appeal was against a decision of the Second Division of the Scottish Court of Session allowing the parties a proof before answer. Lord Hill Watson, the Lord Ordinary, had dismissed the action holding their averment irrelevant and lacking in specification.,

Lord Normand said the British Oxygen Company alleged that the electricity board exercised undue discrimination against industrial users of high-voltage electricity.

It claimed that three tariffs on which it was to be charged were invalid and contrary to the Electricity Act, 1947, which stated that the board should not show "undue preference" or exercise "undue discrimination" as between one class of user and another. The undue discrimination complained of lay in the narrowing of the gap between the unit prices charged for high-voltage and low-voltage supplies, respectively.

The company agreed that the high-voltage tariff was fair, as compared with the low-voltage tariff, when fuel was 38s. a ton, but argued that the fuel variation clause vitiated the tariffs when fuel costs rose above 38s., by distributing the additional cost equally between the two sets of consumers. After saying that on the arguments adduced before the lower courts he agreed with the view taken by the Inner House, Lord Normand referred to new arguments introduced when the appeal was heard by the House of Lords. The electricity board claimed that the test of whether a preference had been shown was simply a matter of price.

This new submission was crucial in the decision of the action and was of the greatest importance to all users of electricity and also of gas. It was, in substance, a new case that the House was asked to consider without the aid of the judgment of the Court of Session. Had that court been informed that the board proposed to put forward a new question of such magnitude it was scarcely conceivable that the application for leave to appeal would have been granted. Justice did not require that the new question should be entertained by the House, and the case should proceed as the Second Division had directed. That might result in a second appeal, but that was a risk the board had taken with their eyes open. He would dismiss the appeal, with costs.

Viscount Simmonds, Lord Tucker, Lord Cohen, and Lord Keith of Avonholm agreed.

Reduction of Capital

In the Chancery Division on July 24, Mr. Justice Vaisey confirmed a reduction of the capital of the Chinese Engineering & Mining Company, Limited, from £2,050,000 to £1,050,000. The petition asking for confirmation of the reduction was opposed by Mr. Edward J. Nathan, holder of 1,000 shares, and Mr. Joseph Nissim, holder of 210 shares.

It was stated that the proposed reduction was to be effected by writing down the ordinary shares of £1 each to 10s. each, the difference being capital lost or unrepresented by available assets. The total involved was £980,000. The issued capital consisted of 1,960,000 ordinary shares of £1, which were credited as fully paid up. Of that number roughly 610,000 were registered shares and 1,350,000 were represented by share warrants to bearer.

Giving judgment, his lordship said it had been alleged that the confirmation of the reduction was the first step in the process of reorganization. The opponents to the petition anticipated they would be prejudiced. The petition was a regular and ordinary application for confirmation of a revision in the normal way. The reduction of the capital had been brought about by a special resolution and only needed confirmation by the court.

Confirming the reduction, the judge ordered the petitioners to pay the opponents costs.

New Catalogues

Exothermic Feeding Compounds. Catalogue No. 123, issued by the Harborough Construction Company, Limited, Market Harborough, opens up with some general notes on methods of running, and follows on with a dissertation on progressive solidification. Next, some useful information is given as to the relative amount of metal to be added for eight of the common types of alloys used in foundry practice, together with notes on their practical implications, including a paragraph on heat losses from feeder heads. Then there are listed three types of mouldable exothermic compounds which the firm market under the trade name of Riserex and their application in practice. The various compounds are then detailed. The brochure, which is of good appearance, is available on writing to Market Harborough.

Foundry Dust-extraction Data. One of the most interesting brochures on the important subject of dust removal from foundry plant has been received from Air Control Installations, Limited, Ruislip, Middlesex. It opens with a diagram of a typical sand-handling system in which the various components are numbered and cross reference is given to each in a series of excellent sketches. These indicate a solution to each separate problem. In addition, there are many general data included, as to the volume and speed of exhaust required for various duties. It is the type of pamphlet which should be kept, as with the purchase of every new machine a fresh dust problem arises and herein may be found a solution. Those interested may obtain the pamphlet by writing to Ruislip.

Dust-control Equipment. A leaflet received from Dallow Lambert & Company, Limited, Thurmaston, Leicester, carries twelve pictures of dust-collecting equipment installed in foundries. Whether a leaflet is adequate for introducing such an important subject is questionable. It does, however, show that consideration has been given to tackling the dust problem at the source of production in many foundry applications. It is available to readers on writing to Leicester.

Pipette Filler. A leaflet received from Griffin & George, Limited, Ealing Road, Alperton, Wembley, Middlesex, describes and illustrates a simple apparatus capable of eliminating the potentially dangerous method of filling pipettes by sucking by the mouth.

MANUFACTURING SECTIONS of the Crown Spring Company, Limited, a subsidiary of George Salter & Company, Limited, are being transferred from premises in Littleton Street, West Bromwich, to the new Salter factory at Spring Road, Smethwick.

New Patents

(Copies of complete specifications are obtainable from the Patent Office Sales Branch, 25, Southampton Buildings, Chancery Lane, London, W.C.2, price 3s.)

750,521. R. E. Warnant, 36 Avenue des Phalenes, Brussels, Belgium.

A method of converting iron into steel having a nitrogen content lower than that which is attained by conversion with atmospheric air. The temperature of the blast is maintained above 225 deg. C. throughout the conversion, at least half of the blowing being effected with a mixture of oxygen and steam at a temperature between 250 and 350 deg. C.

750,572. K. Schmidt, 17 Schottstrasse, Stuttgart, N. Germany.

A process of melting and treating non-ferrous metals which is an improvement or modification of that claimed in patent No. 689,223. In the carrying out of metal/slag reactions in rotary furnaces, the furnace is rotated for the melting at speeds in a manner known *per se* of 0.5 to 3.0 rev. per min. After the contents have melted it is rotated at a speed above 3 rev. per min. (preferably 3.3 to 10.0).

750,647. Mannesmann A.G., 1b Mannesmannufer, Düsseldorf, Germany.

An apparatus for simultaneously casting a number of endless lengths by continuous casting. An interchangeable tiltable trough has, at the top of one or both of its side walls, short overflow channels. These are adapted to be completely or partially closed by plugs or slide members, which are put in effective (channel closing) position either within the channels or in front of, or in the rear, of them.

750,709. Eisenwerke Gelsenkirchen A.G., 2-4 Hohenzollerstrasse, Gelsenkirchen, Germany.

A means of feeding molten metal during the continuous casting of work pieces of either solid or hollow cross-section. The molten metal flows to its level in the mould cavity by way of a moving discharge device, the position of which is constantly changed. The discharge opening(s) of the device consist(s) of an open-topped slot in the side wall of the discharge device.

750,810. Ferro Engineering Company, Hanna Building, Cleveland, Ohio, USA.

In casting metal ingots, a hot top consists of a veneer applied to the inner surface of the insulating brick lining. The special advantages and the difficulties overcome with the use of this new development are enumerated.

750,851. Ilva Alti Forni e Acciaierie D'Italia, S.A., Stabilimento di Cogoleta, Genoa-Cogoleta, Italy.

A rotary mould for producing centrifugally cast-iron pipes. It has an end flange adapted to form an element of a bolted joint. Within the portion of the mould in which the flange of the pipe is cast, there are secured block of suitable material, *e.g.*, steel, shaped to form in the flange recesses or slots whereby bolts for the joint may be attached to the flange without the necessity for forming holes in it.

TWO WOMEN were among 24 employees of W. & T. Avery, Limited, weighing-machine manufacturers, etc., of Birmingham, who received gold watch awards for 40 years' service with the company. Four men employees are to be awarded £50 each for 50 years' service.

Company News

WELLMAN SMITH OWEN ENGINEERING CORPORATION, LIMITED—A final dividend of 15 per cent., making 22½ per cent. for the year ended March 31, is recommended on the £800,000 ordinary capital as increased by a one-for-seven scrip issue. The 1954-55 final of 12½ per cent. made a total of 20 per cent. on £700,000.

RUSTON & HORNSBY, LIMITED, engineers and ironfounders, of Lincoln—Group profits declined from £1,716,041 to £1,565,208 in the year ended March 31 last, but more is distributed by way of dividends. The dividend recommendation is 9 per cent. on an ordinary capital increased to £6,150,000 by a 50 per cent. scrip issue and absorbs £318,264.

ASSOCIATED BRITISH ENGINEERING, LIMITED—The group enjoys healthy order-books and is continuing to obtain a reasonable volume of new orders, says Mr. L. W. Robson, the chairman, in his review with the accounts for the year ended March 31. The chairman feels it reasonable to predict, therefore, that the group should be able to continue to show satisfactory results for the current year.

SHEEPBRIDGE ENGINEERING, LIMITED—The directors are increasing the final dividend on the £1,906,690 ordinary capital from 12½ per cent. in 1954-55 to 17½ per cent. for the year to March 31, 1956. With the unchanged interim, the total is brought up to 22½ per cent., compared with 17½ per cent. previously. Group profit before tax has risen from £650,398 in the previous year to £1,015,110.

UNITED GAS INDUSTRIES, LIMITED—The group is raising the final dividend on the ordinary capital from 9¼ per cent. to 9¾ per cent. to make 14 per cent. for the year ended March 31 last, against 13 per cent., and the distribution on the 1s. deferred from 10½d. to 1s. 1½d. per share. Group net profits, after all charges, expanded from £140,207 to £243,746, of which £100,000 (£9,000) is transferred to plant replacement reserve.

BIRMINGHAM SMALL ARMS COMPANY, LIMITED—The board has appointed Lazard Bros. & Company, Limited, merchant bankers, and Deloitte, Plender, Griffiths & Company, chartered accountants, as independent advisers to make an examination of and to report on the structure and organization of the group. The extra-ordinary meeting of the company requisitioned by Sir Bernard Docker and other stockholders was held in London on Wednesday.

BROOK MOTORS, LIMITED—Underwriting is being arranged for the rights issue by the company. The issue will consist of 300,000 10s. ordinary shares at 30s. each. It is announced that 285,215 of the new shares will be provisionally allotted on a one-for-four basis to ordinary shareholders at July 18 who may also apply for the balance of the issue and shares not taken up by way of rights. Provisional allotment letters, etc., were posted on Friday, July 27, and dealings commenced on Monday.

DAVEY, PAXMAN & COMPANY, LIMITED, diesel-engine manufacturers, etc., of Colchester—Although the company's profit fell from the exceptionally high level of £815,416 to £472,655 for the year ended March 31, 1956, Mr. H. Riggall, the chairman, says the order-book now stands at a reasonably satisfactory level. The ordinary dividend is held at 10 per cent., less tax. Activity during the current year is expected to be well maintained, and on the basis of present trends the current year could show results similar to those under review.

News in Brief

PLANS have been prepared for the erection of extensions to the premises of British Bath Company, Limited, Long Drive, Greenford, Middx.

THE State Hydro-Electric Department of New Zealand has awarded a contract to Boving & Company, Limited, London, W.C.2, for three Kaplan turbines for the Waipapa power station on the Waikato river.

THE OFFICES of Baker Perkins (Exports), Limited, a subsidiary of Baker Perkins, Limited, engineers, of Peterborough, are shortly to be transferred to Westwood House, Swallow Street, Piccadilly, London, W.1.

THE Federation of Light Metal Smelters announces that its members' average selling prices for June, to the nearest 10s., have been calculated as follows:—LM 1, £188 per ton; LM 2, £188; LM 4, £202; LM 6, £210.

THE QUEEN ANNE blast furnace of the Appleby-Frodingham Steel Company, a branch of the United Steel Companies, Limited, came off for a reline on July 21. The hearth is being enlarged from 27-ft. dia. to 31 ft.

FOLLOWING complaints to Austerfield Parish and Doncaster Rural Councils about dust-fall from the works chimney of General Refractories, Limited, the company is to instal arrestors to prevent the dust from reaching the atmosphere.

QUASI-ARC, LIMITED, of Bilston, Staffordshire, announce the development of a four-wheeled-type Flexitor suspension undergear for attachment to standard 300 and 400 amp. diesel and petrol-driven welding sets and the double operator 300 amp. diesel set.

DR. O. P. EINERL has been asked to take the chair at the inaugural meeting in October of the newly-formed Southampton Metallurgical Society. The lecture that evening will be concerned with the fatigue of metals; a full programme of meetings for the current session is in course of preparation.

INTERNATIONAL FURNACE COMPANY, LIMITED, of Aldridge Staffs, have concluded an agreement to represent and manufacture the products of Holcroft & Company, of Detroit, Michigan. The agreement covers Great Britain, Australasia and all British colonies and dominions, except Canada, for the manufacture of heat-treatment furnaces.

JOHN HARPER & COMPANY, LIMITED, of Willenhall, Staffs, have been running a suggestions scheme since 1949 and have just paid the highest award—to a 21-year-old member of the foundry planning department, Mr. Arthur Griffiths. He has received £45 with 5 guineas holiday money for suggesting economies in shop planning.

THE BOARD of Imperial Chemical Industries, Limited, have decided to make no further increase in the home-trade prices of the company's chemicals, dyestuffs, explosives, fertilizers, fibres, paints, pharmaceuticals, and plastics at least until June 30, 1957, provided no unexpected or exceptional factors intervene, and provided the company does not incur any major increase in the cost of freight or fuel before that date.

PLANS to open a tractor equipment assembly factory, on a site still to be chosen near Glasgow, have been announced by an American firm, Hyster Company, of Portland, Oregon. The new plant will produce construction and logging equipment and will supplement the plant established by the same company in Nijmegen, in the Netherlands. Operations are expected to begin in the autumn. The Hyster Company are an allied company of the Caterpillar Tractor Company, Inc., who are laying out a new factory at Tannochside, near Glasgow.

METROPOLITAN - VICKERS ELECTRICAL COMPANY, LIMITED, is revising its "Register of Ex-Apprentices and Ex-Trainees." The last edition, containing 10,000 short biographies, was published in 1950, and forms asking for present particulars have been sent to all those whose addresses are known to the company. Any ex-apprentice or ex-trainee who has not received a form (or has not yet replied to one) is invited to write to Mr. R. F. Marshall, manager, education department, Metropolitan-Vickers Electrical Company, Limited, Trafford Park, Manchester, 17.

MUCH INTEREST is being shown in the programme the Welsh Economic Development Council is preparing for the 1958 Festival of Wales. It includes exhibitions and displays of Welsh craft and manufactured goods, "Welsh Weeks" featuring window displays of goods in the shopping centres of Wales, and the production of a trade-promotion publication. In addition to staging the Festival, Wales is to be host to the 1958 sixth British Empire and Commonwealth Games, and the Council is giving the lead in promoting world-wide interest in the products and industrial facilities Wales has to offer.

A NEW OIL-FIRED TUNNEL KILN, to be known as the "Kirkby Kiln," was recently put into operation at the Worksop plant of General Refractories, Limited, for the burning of basic refractories. The kiln is capable of firing at temperatures up to 1,650 deg. C. and has a total overall length of 346 ft. It will hold 56 cars, each with a capacity of approximately five tons, giving a weekly output of 600 tons of fired bricks. All the refractories were supplied from various works of the G.R. group and those in the hot zone are of Sillmax 63/100, a special grade of sillimanite brick. The whole project was completed to an overall scheme by General Refractories, Limited, who placed the contract for the design and construction of the tunnel kiln with British Ceramic Service Company, Limited, Glasgow, C.2.

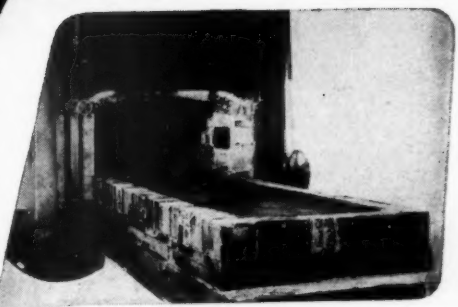
CITY AND GUILDS OF LONDON INSTITUTE announce that the advisory committee has recently reviewed the syllabuses for foundry practice with the view to incorporating techniques recently introduced into the foundry. In the Intermediate examination, normal, hot-blast, water-cooled and basic cupolas have been included, together with special moulding processes such as shell moulding, CO_2 and investment casting. A new clause has also been introduced governing the safety precautions to be observed in the foundry. The final syllabus has been amended to cover sands for specialized processes and the inspection of castings by radiographic and other non-destructive methods.

FRIDAY, JULY 27, marked the completion of a five-year plan for the total transfer to Walsall of the foundry and staff at the Soho Works of W. & T. Avery, Limited. A small ceremony was held when executives and senior employees watched the last cast being poured. This was a plaque to commemorate the occasion, which will eventually be placed in the company's new foundry at Tame Bridge, Walsall. As stated by Mr. Morley, managing director, the chief reason for all foundry work being transferred to the new plant at Walsall is the lack of space for future expansion at Birmingham. It was also considered unwise to spend any considerable amount of money on improving the old buildings as the foundations were badly affected by the air raids of the last war.

BOGIE TOPS

Examples of another of the many uses for REFRACTORY CONCRETE

Atlas Steel Foundry. Bogie for mould drying stove, topped with Refractory Concrete. Bogie is 25ft. long and 10ft. wide, the topping being 6in. thick. The door shown is lined with Ciment Fondu insulating concrete.



Wm. Jessop & Sons Ltd. Bogie is 15ft. long by 5ft. wide topped by 6½in. of Refractory Concrete.

—Its monolithic construction eliminates troubles due to displacement of bricks

—It will withstand severe thermal shock without spalling

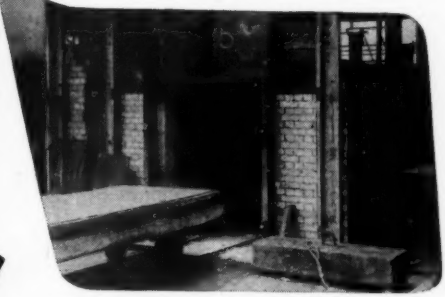
—It is ready for use and of great strength and hardness in 24 hours

—It has no appreciable drying shrinkage or after-contraction

—It is stable under load up to 1300°C. (2400°F.)

Bogie used at large Northern Foundry, in gas-fired tunnel oven, for annealing maleable iron at 1050° C. Bogie is 7ft. by 7ft. and the Refractory Concrete is 12in. thick.

Crossley Bros. Ltd. Bogie for gas-fired annealing oven operating at 650° C. The door is also lined with Refractory Concrete.



REFRACTORY CONCRETE
the adaptable Refractory material made with crushed firebrick and **CIMENT FONDU**

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ALUMINOUS CEMENT

CONCRETE ROCK-HARD WITHIN ONE DAY

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You are invited to write for further details and photographic examples

AP 3-7306

Raw Material Markets

Iron and Steel

Summer holidays are enabling major repairs to be carried out to plant. In most cases the foundries will not accept deliveries during the holiday period, as they will have sufficient stocks of pig-iron and coke on hand when they return—an indication of the present reduced pressure for supplies, as up to a short time ago the engineering foundries, in particular, were anxious to accept available supplies during the holiday periods. The engineering and speciality foundries, apart from those catering mainly for the motor-car industry, continue to be the most heavily engaged and outputs of high-duty castings are at a good level. Supplies of pig-iron in low phosphorus and hematite grades to the engineering foundries are easier and most consumers are able to obtain the required tonnages without much difficulty.

Fresh consumers of these grades, however, are unable to acquire all the tonnages they need, especially in the case of those foundries which have found it necessary to undertake new lines, owing to scarcity of work in their normal range of production.

Business at the light foundries shows no definite signs of a general improvement, although some units are more busily employed than others. The jobbing foundries are fairly active, but the textile foundries could undertake much more business. Outputs of high-phosphorus iron are meeting current demands, but there is little to spare from the present reduced production of this grade.

Demand for scrap from the ironfoundries are slackening and merchants' stocks are higher than for some time, particularly in the light and medium grades, although the demand is better for heavy cast-iron and machinery scrap. Foundry coke is being received in adequate quantities for current consumption requirements, while ganister, limestone, and firebricks are readily obtainable.

The re-rollers continue to be well employed and regular fresh business is forthcoming from home consumers and stockists for all their products of small bars, light sections, strip, etc. Some business is also on hand for oversea customers. Fairly good supplies of steel semis are on hand and deliveries have not so far been affected by the dispute in the steel industry at home or by the United States steel strike.

Non-ferrous Metals

World events rather than demand are pushing non-ferrous metal market prices higher. The Egyptian Government's action over the Suez Canal has, of course, caused a big stir and with the news of a strike at the Bancroft Mine on the Rhodesian Copperbelt, copper prices on the London Metal Exchange sailed over the £300 level on Monday.

Last week copper had been in the doldrums in face of poor consumer demand, the United States steel strike, good supplies in the hands of the US fabricators, and expectations that the United Kingdom Government would begin to unload its copper stocks later this month. Nevertheless, the price held up well, and it was not altogether surprising that when it was announced that the US steel strike had been settled there was not a great deal of response in the price on the LME and little impact in America.

In the US attention is drawn to the forthcoming negotiations between the United Steelworkers' Union and the American Smelting & Refining Company and the Kennecott Copper Corporation. The present contract expires on August 31. The Laurel Hill Refinery of the Phelps Dodge Company has already started negotiations and no difficulties are expected in either discussion.

Lead has been a better market recently, particularly in the States, buying coming from cablemakers, battery manufacturers, and from the chemical industry. The Suez situation has helped shore up the price on the LME. Basically, however, the statistical position is not strong, although it is thought that demand will become more substantial after the holiday period.

But for the Suez affair, zinc would still be giving ground gradually as it has done over the past few weeks. However, fear of an interruption to the flow of supplies has bolstered the price. In the States the market is quiet, and, indeed, much quieter than had been expected following the settlement of the US steel strike.

Tin is a bull market. Not only has the settlement of the steel strike paved the way for a resumption of demand in America, but there are, too, the bullish influences of Col. Nasser's action and the strike call to 16,800 members of the Malayan Mining Employees' Union to stop work on August 7. Labour unrest at the Nigerian tin mines has also to be taken into account.

Official metal prices were as follow:—

COPPER, Standard—*Cash:* July 26, £290 to £291; July 27, £290 to £291; July 30, £310 to £311; July 31, £305 to £305 10s.; August 1, £307 10s. to £308 10s.

Three Months: July 26, £289 to £289 10s.; July 27, £289 to £289 10s.; July 30, £308 to £309; July 31, £304 to £304 10s.; August 1, £306 to £306 10s.

TIN, Standard—*Cash:* July 26, £755 to £756; July 27, £768 to £769; July 30, £779 to £780; July 31, £784 to £785; August 1, £778 to £779.

Three Months: July 26, £753 to £754; July 27, £761 to £762; July 30, £775 to £777; July 31, £778 to £779; August 1, £773 to £774.

LEAD—*Second half July:* July 26, £112 15s. to £113; July 27, £112 15s. to £113; July 30, £114 5s. to £114 10s.; July 31, £115 15s. to £116. *First half August:* August 1, £115 15s. to £116.

Second half October: July 26, £111 15s. to £112; July 27, £112 to £112 5s.; July 30, £113 10s. to £113 15s.; July 31, £114 15s. to £115. *First half November:* August 1, £114 10s. to £114 15s.

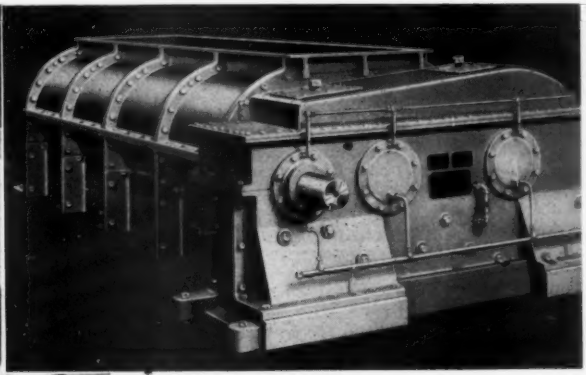
ZINC—*Second half July:* July 26, £93 10s. to £93 15s.; July 27, £93 10s. to £94; July 30, £95 to £95 5s.; July 31, £95 10s. to £95 15s. *First half August:* August 1, £96 to £96 10s.

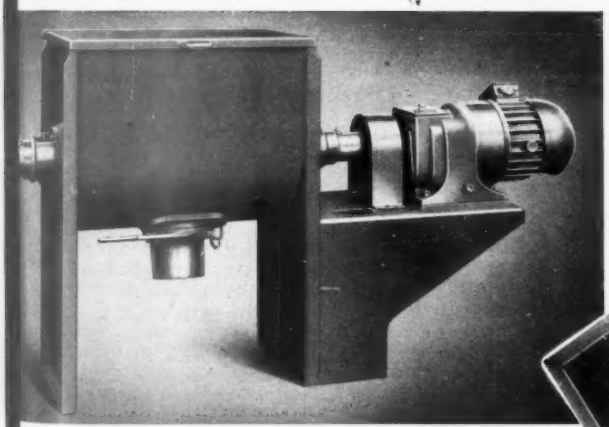
Second half October: July 26, £92 10s. to £92 15s.; July 27, £93 5s. to £93 10s.; July 30, £94 5s. to £94 15s.; July 31, £94 10s. to £95. *First half November:* August 1, £95 to £95 5s.

Beware of "Booby Traps"

The industrial safety division of the Royal Society for the Prevention of Accidents is organizing a "safety week" during November 5 to 10. This time they are, by means of posters, publicity and other devices, concentrating on the elimination of "booby traps." For the benefit of a section of overseas readers, a booby trap represents a condition of affairs, which should be obvious to every intelligent person, but somehow or other is overlooked with potentially dangerous consequences. The leaflets, "Watch Out for these Booby Traps," are excellent.

Batch and Continuous Sand Mixers





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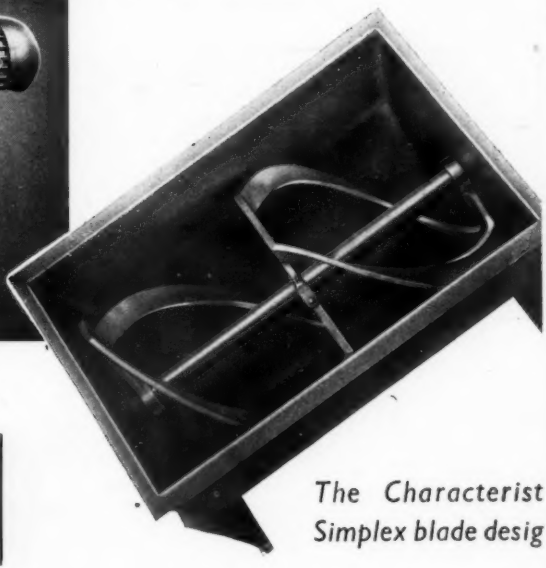
Built in standard sizes wi continuous outputs of 6 tons 120 tons per hour of thorough aerated and homogeneously mix moulding sand.



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CH MIXERS Made in a variety of sizes.

BAKER PERKINS LTD
Engineers
ESTWOOD WORKS - PETERBOROUGH

Current Prices of Iron, Steel, and Non-ferrous Metals

(Delivered unless otherwise stated)

August 1, 1956

PIG-IRON

Foundry Iron.—No. 3 IRON, CLASS 2:—Middlesbrough, £17 11s. 0d.; Birmingham, £17 3s. 3d.

Low-phosphorus Iron.—Over 0.10 to 0.75 per cent. P, £20 8s. 0d., delivered Birmingham. Staffordshire blast-furnace low-phosphorus foundry iron (0.10 to 0.50 per cent. P, up to 3 per cent. Si), d/d within 60 miles of Stafford, £20 12s. 3d.

Scotch Iron.—No. 3 foundry, £21 14s. 6d., d/d Grangemouth.

Cylinder and Refined Irons.—North Zone, £23 16s. 6d.; South Zone, £23 19s. 0d.

Refined Malleable.—P, 0.10 per cent. max.—North Zone, £25 4s. 0d.; South Zone, £25 6s. 6d.

Hematite.—Si up to 2 per cent., S. & P. over 0.03 to 0.05 per cent. :—N.-E. of England (local iron), £21 7s. 6d.; Scotland (Scotch iron), Zone S. 1, £21 14s. 0d.; Sheffield, £22 14s. 6d.; Birmingham, £23 2s. 0d.; Wales (Welsh iron), £21 7s. 6d.

Basic Pig-iron.—£18 3s. 0d. all districts.

FERRO-ALLOYS

(Per ton unless otherwise stated, delivered)

Ferro-silicon (6-ton lots and over).—45 per cent. Si, £48 0s. 0d. to £50 5s. 0d., scale 16s. 0d. to 17s. 6d. per unit; 75 per cent. Si, £70 0s. 0d. to £73 2s. 6d., scale 16s. 0d. to 17s. 6d. per unit.

Ferro-vanadium.—50/60 per cent., 27s. 6d. per lb. of V.

Ferro-molybdenum.—65/75 per cent., carbon-free, 11s. 6d. per lb. of Mo.

Ferro-titanium.—20/25 per cent., carbon-free, £250 0s. 0d.; 38/40 per cent., £299 0s. 0d.

Ferro-tungsten.—80/85 per cent., 17s. 2d. per lb. of W.

Tungsten Metal Powder.—98/99 per cent., 20s. 2d. per lb. of W.

Ferro-chrome (6-10 ton lots).—4/6 per cent.C, £93 10s.0d. to £95 0s. 0d., basis 60 per cent. Cr, scale 29s. 9d. to 32s. 0d. per unit; over 6 per cent. C, £92 10s. 0d. to £93 0s. 0d., basis 60 per cent. Cr, scale 29s. 9d. to 32s. 0d. per unit; 2 per cent. C,* 2s. 1d. per lb. Cr; 1 per cent. C,* 2s. 1½d. per lb. Cr; 0.15 per cent. C,* 2s. 2½d. per lb. Cr; 0.10 per cent. C,* 2s. 2¾d. per lb. Cr; 0.06 per cent. C,* 2s. 3d. per lb. Cr.

Metallic Chromium.—98/99 per cent., 7s. 0d. to 7s. 6d. per lb.

Metallic Manganese.—93/95 per cent., carbon-free, £249 0s. 0d.; 96/98 per cent., £259 0s. 0d. to £265 0s. 0d.

Ferro-columbium.—65/75 per cent., Nb + Ta, 22s. 6d. to 23s. 6d. per lb., Nb + Ta.

Ferro-manganese (home).—78 per cent., £66 0s. 0d.

SEMI-FINISHED STEEL

Re-rolling Billets, Blooms, and Slabs.—BASIC: Soft, u.t., £28 19s. 0d.; tested, 0.08 to 0.25 per cent. C, £29 19s. 0d.; hard (0.41 to 0.60 per cent. C), £31 0s. 6d.; silico-manganese, £39 10s. 0d.; free-cutting, £33 3s. 0d. SIEMENS MARTIN ACID: Up to 0.25 per cent. C, £36 14s. 6d., silico-manganese, £39 17s. 6d.

Billets, Blooms, and Slabs for Forging and Stamping.—Basic, soft, up to 0.25 per cent. C, £34 13s. 6d.; basic, hard, over 0.41 up to 0.60 per cent., C, £35 16s. 0d.; acid, up to 0.25 per cent. C, £38 17s. 6d.

FINISHED STEEL

Heavy Plates and Sections.—Ship plates (N.-E. Coast), £35 7s. 0d.; boiler plates (N.-E. Coast), £37 17s. 0d.; floor plates (N.-E. Coast), £36 16s. 0d.; sectional material, N.-E. Coast, £33 16s. 6d.

Small Bars, Sheets, etc.—Rounds and squares, under 3 in., untested (4-ton lots). £36 3s. 0d.; flats, 5 in. wide and under (4-ton lots), £36 3s. 0d.; hoop and strip, £36 12s. 6d.; uncoated strip mill coils, hot rolled, under 3mm. to 12g., £38 16s. 0d.; black sheets (hand mill), 17/20 g., £50 4s. 6d.; galvanized corrugated sheets, 24 g., £62 7s. 0d.

Alloy Steel Bars.—1 in. dia. and up: Nickel, £61 13s. 9d.; nickel-chrome, £85 10s. 6d.; nickel-chrome-molybdenum, £96 16s. 6d.

NON-FERROUS METALS

Copper.—Cash, £307 10s. 0d. to £308 10s. 0d.; three months, £306 0s. 0d. to £306 10s. 0d.; settlement, £308 10s. 0d.

Copper Tubes, etc.—Solid-drawn tubes, 3s. 0½d. per lb.; rods, 348s. 3d. per cwt. basis; 20 s.w.g., 381s. 3d. per cwt.

Tin.—Cash, £773 0s. 0d. to £779 0s. 0d.; three months, £773 0s. 0d. to £774 0s. 0d.; settlement, £779 0s. 0d.

Lead (Refined Pig).—First half August, £115 15s. 0d. to £116 0s. 0d.; first half November, £114 10s. 0d. to £114 15s. 0d.

Zinc.—First half August, £96 0s. 0d. to £96 10s. 0d.; first half November, £95 0s. 0d. to £95 5s. 0d.

Zinc Sheets, etc.—Sheets, 15 g. and thicker, all English destinations, £126 10s. 0d.; rolled zinc (boiler plates), all English destinations, £124 5s. 0d.; zinc oxide (Red Seal), d/d buyers' premises, £110.

Brass Tubes, etc.—Solid-drawn tubes, 2s. 5½d. per lb.; rods, drawn, 3s. 3¾d.; sheets to 10 w.g., 323s. 0d. per cwt.; wire, 3s. 1¾d.; rolled metal, 308s. 0d. per cwt.

Brass (Brazing).—BS1400, B3 (65/35), — ; B6 (85/15), — ; BS249, —.

Brass (High Tensile).—BS1400, HTB1 (30 tons), — HTB2 (38 tons), — ; HTB3 (48 tons), — .

Gunmetal.—BS1400, LG2 (85/5/5/5), — ; LG3 (86/7/5/2), — ; G1 (88/10/2/½), — ; (88/10/2/1), — .

Phosphor Bronze.—BS1400, PB1 (AID released), — per ton.

Phosphor Bronze Strip, etc.—Strip, 446s. 3d. per cwt.; sheets to 10 w.g., 470s. 9d. per cwt.; wire, 4s. 5½d. per lb.; rods, 3s. 11½d.; tubes, 3s. 9½d.; chill cast bars: solids 3s. 11d., cored 4s. 0d. (CHARLES CLIFFORD, LIMITED).

Nickel Silver, etc.—Rolled metal, 3 in. to 9 in. wide × 0.056, 4s. 2¾d. per lb.; round wire, 10g. in coils (10 per cent.), 4s. 7d.; special quality turning rod, 10 per cent., ½ in. dia., in straight lengths, 4s. 6d. All prices are net.

Other Metals.—Magnesium, ingots, 2s. 4d. per lb. Antimony, English, 99 per cent., £210 0s. 0d. Quicksilver, ex-warehouse, £84 10s. 0d. Nickel, £519 0s. 0d. Aluminium ingots, £190 10s. 0d.; aluminium bronze (BS1400), AB1, — ; AB2, — . Solder, brazing, BS1945, type 8 (50/50), 3s. 1d. per lb., type 9 (54/46), 3s. 4½d. per lb.

* Average 68-70 per cent.

Focus on conveyor belting proves Goodyear superiority

There is obviously only one way of proving to yourself beyond any doubt that Goodyear conveyor belting gives long and reliable service. That's by installing it.

But for proof in advance there's the record of efficiency of Goodyear conveyor belts in thousands of existing installations in this country—in steelworks, power stations, mines, quarries, factories and foundries.

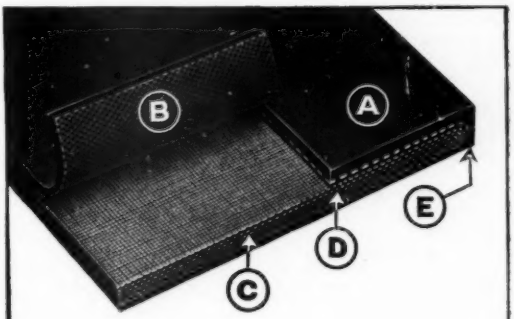
At a big steelworks, for instance, Goodyear belts conveying hot sinter are lasting over twice as long as other makes previously used.

QUICK PROOF

Focus on conveyor belting proves Goodyear superiority, and quickly confirms that Goodyear belting makes every conveying job an economic proposition.

The emphasis is on *every*. Whatever the conveying work, there's a "job-designed" Goodyear belt to do it at the lowest cost per ton.

This cost-saving is ensured by the exceptionally high quality built into every Goodyear belt. And this quality is ensured by rigid adherence to raw material specifications and stage by stage production inspection.



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Personal

Mr. J. S. CANNING has been appointed general sales manager of Ransomes Sims & Jefferies, Limited, Orwell Works, Ipswich.

Mr. HARRY DOUGHTY, managing director, Moston Malleable Castings Company, Limited, Manchester, last month celebrated his 70th birthday, and also his 50th year with the firm.

Colonel C. F. HITCHINS has tendered his resignation as chairman of Follsain-Wycliffe Foundries, Limited, and Mr. H. M. Jones, vice-chairman, has been appointed in his stead.

Mr. WILFRED BYNG KENRICK, a director of Archibald Kenrick & Sons, Limited, West Bromwich, celebrated his golden wedding anniversary on July 24. Mr. Kenrick is 83, and still cycles daily to work whatever the weather.

Mr. H. C. SARGENT has resigned as chairman of Bilston Foundries, Limited, owing to ill-health. He retains his seat on the board as consultant director. Mr. T. I. HOBART, managing director, has been appointed chairman of the board.

Mr. KEPPEL F. MASSEY, chairman and managing director of B. & S. Massey, Limited, makers of power hammers, dropstamping plant, etc., of Openshaw, Manchester, has been elected a director of the British Engine Boiler & Electrical Insurance Company, Limited.

Mr. G. A. DUMMETT has been elected to the board of the A.P.V. Company, Limited. He joined the company in 1935, and has successively been laboratory manager and scientiffic manager, responsible for the research and development organization of the company.

Mr. A. G. E. ROBIETTE, a director of John Miles & Partners (London), Limited, consulting engineers to the metallurgical industries, etc., and of Metallurgical Engineers, Limited, London, E.C.4, has been awarded the degree of Doctor of Science of the University of Wales.

Sir CHARLES LILLICRAP, K.C.B., M.B.E., D.SC.(ENG.), has been elected president of the Institute of Welding for 1956/57 and was installed at the annual general meeting of the Institute on July 19. Mr. J. STRONG, M.A., a director of British Oxygen Company, Limited, has been elected vice-president.

When long-service awards were presented to employees of John Thompson, Limited, engineers, boilermakers, etc., of Wolverhampton, Mr. W. R. EDWARDS, a director, topped the list of those with 50 years' service. Mr. Edwards was the first apprentice at the original John Thompson company.

To return to commerce, Capt. C. A. KERSHAW is relinquishing his appointment as secretary-general of the Engineering Industries Association at the end of this month. He is joining the boards of the Bestwood Company, Limited, and Plowright Bros., Limited, makers of colliery plant and equipment, of Chesterfield.

The new president of the Locomotive and Allied Manufacturers of Great Britain is Mr. HAROLD WILMOT, chairman and managing director of Beyer, Peacock & Company, Limited. Mr. C. C. H. WADE, manager, traction sales and contracts, of the English Electric Company, Limited, has been elected chairman of the association.

English Steel Corporation, Limited, announce the appointment of Mr. J. T. W. DEWAR as an additional director of the company, with effect from September 1. Mr. Dewar is deputy managing director of Firth-Vickers Stainless Steels, Limited, and managing director of Shepcote Lane Rolling Mills, Limited, both of which appointments he retains.

London University has conferred the title of Professor Emeritus on Dr. S. J. DAVIES, who retired last year from the Chair of Mechanical Engineering at King's College, Prof. L. HAWKES, on his retirement from the Professorship of Geology at Bedford College, and Prof. W. J. JOHN, on his retirement from the Chair of Electrical Engineering at Queen Mary College.

Because of his other commitments, LORD BILSLAND has resigned from the Scottish Area Board of the British Transport Commission. He is president of the Scottish Council (Development and Industry) and until last year he was chairman of its executive committee. Among his business appointments are directorships of Colvilles, Limited, and John Brown & Company, Limited.

Sir ERNEST R. CANNING, chairman of W. Canning & Company, Limited, Birmingham, and managing director from 1920 to 1953, celebrates his 80th birthday this month. Until his recent retirement, Sir Ernest served for many years on the regional council of the Federation of British Industries and in 1952 was regional chairman. He received his knighthood in 1939, and was Lord Mayor of Birmingham and High Sheriff of Warwickshire in 1946-47.

Obituary

Mrs. JANET DIX, a partner in Walter Dix & Company, heating and ventilating engineers, etc., of Newcastle-upon-Tyne, has died at the age of 83.

The death is announced of Mr. NORMAN LONGSON, a partner in the old-established firm—founded in 1870—of Matthew Longson, Market Place Foundry, Chapel-en-le-Frith. He was 64 years old.

Mr. GEORGE EDGAR LUMB, managing director of Graham & Normanton, Limited, machine-tool makers, of Halifax, has died at the age of 60. He was formerly a manager with Henry Broadbent, Limited, the Sowerby Bridge (Yorks) machine-tool concern.

Mr. GEORGE A. LANGTON, senior partner of the old-established (1863) business of Samuel Langton & Sons, brass founders, of Mersey Brass Works, Heaton Lane, Stockport, died on July 20. The business will now be conducted by his son, Mr. Samuel Langton.

The death is announced of Mr. THOMAS GOODWIN, a past-president of the East Midlands branch of the Institute of British Foundrymen, which he joined in 1919. He retired from business about six years ago, when he resigned from the board of E. S. Lord, Limited, after an association of 20 years with that company.

Mr. JAMES U. VASS, a retired director of the Consolidated Pneumatic Tool Company, Limited, and formerly works manager at the company's Fraserburgh toolworks for many years, died on July 25. An Aberdeen man, Mr. Vass entered the toolworks in 1910 as a fitter, and rose to be works manager and a director of the company. During his long service he saw the Fraserburgh works grow to six times its former size. He retired from his directorship almost two years ago. Mr. Vass, who was awarded the M.B.E. in 1943, was for 12 years chairman of the Aberdeen district committee of the Scottish Board for Industry, a former chairman of the Aberdeen Regional Production Board, and a member of the Aberdeen Reconstruction Panel.

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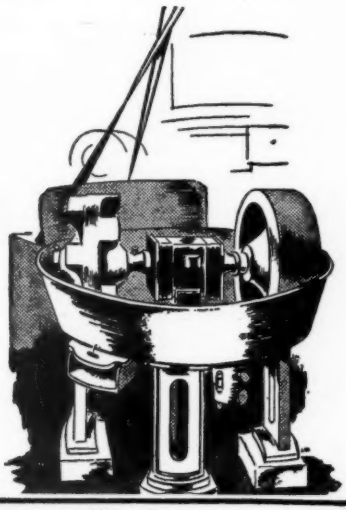

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Pig-iron and Steel Production

Statistical Summary of May Returns

The following particulars of pig-iron and steel produced in Great Britain are from statistics issued by the British Iron and Steel Federation. Table I summarizes activities during the past six months. Table II gives production of steel ingots and castings in May, and Table III, weekly average production of finished steel. Table IV gives the production of pig-iron and ferro-alloys in May, 1956, and furnaces in blast. (All figures weekly averages in thousands of tons.)

TABLE I.—*Iron and Steel Price Index and General Summary of Pig-iron and Steel Production.*

Period.	B.o.T. Price Index, 1938 = 100.			Iron-ore output.	Imptd. ore used.	Coke to blast-furnaces.	Pig-iron, ferro-alloys prod.	Scrap used in steel prod.	Steel (incl. alloy).			
	I. & S.	Coal.	Basic[1] materials (excl. fuel)						Imports.[2]	Prod. ingots, castings.	Delivrs. finished steel.	Stocks.[3]
1953	260	350	506	304	207	237	215	188	17	339	262	962
1954	263	364	498	299	234	238	229	198	7	356	277	931
1955	276	399	520	311	244	246	240	213	20	381	305	1,183
1955—Dec. ..	285	435	539	313	268	261	250	208	35	382	320	1,183
1956—Jan. ..	285	436	537	328	278	270	261	222	38	405	337	1,208
Feb.[4]	285	437	538	315	284	269	263	226	37	418	332	1,220
Mar. ..	285	439	540	346	276	273	262	231	37	426	359	1,250
April	285	440	538	324	284	269	254	226	42	421	349	1,279
May[4]	297	433	541	306	274	255	247	213	29	396	—	1,305

* Five weeks, all tables and months shown. † Weekly average of calendar month. ‡ Stocks, mainly ingots and semi-finished, at the end of the years § Used in non-food manufacturing industry.

TABLE II.—*Weekly Average Production of Steel Ingots and Castings in May* 1956

District.	Open-hearth.		Bessemer.	Electric.	All other.	Total.		Total ingots and castings.
	Acid.	Basic.				Ingots.	Castings.	
Derby, Leics., Notts., Northants and Essex ..	—	4.1	14.2 (basic)	2.4	0.2	19.6	1.3	20.9
Lancs. (excl. N.W. Coast), Denbigh, Flints. and Cheshire	1.7	28.3	—	2.2	0.3	31.2	1.3	32.5
Yorkshire (excl. N.E. Coast and Sheffield) ..								
Lincolnshire	—	41.9	—	—	0.1	41.8	0.2	42.0
North-East Coast	0.6	79.0	—	1.4	0.5	79.5	2.0	81.5
Scotland	2.6	47.0	—	2.6	0.5	50.3	2.4	52.7
Staffs., Shrops., Worcs. and Warwick	—	20.4	—	1.2	0.7	20.5	1.8	22.3
S. Wales and Monmouthshire	6.1	70.3	6.8 (basic)	1.2	0.1	83.9	0.6	84.5
Sheffield (incl. small quantity in Manchester)	9.3	32.3	—	11.3	0.4	51.4	1.9	53.3
North-West Coast	—	1.8	4.3 (acid)	0.5	0.1	6.5	0.2	6.7
Total	20.3	325.1	25.3	22.8	2.9	384.7	11.7	396.4[4]
April, 1956	18.0	351.5	26.1	22.7	2.8	409.5	11.6	421.1
May, 1955	22.9	328.0	25.0	22.5	3.2	390.1	11.5	401.6

TABLE III.—*Production of New Non-alloy and Alloy Finished Steel.*

Product.	1954.	1955.	1955.	1956.	
			April.	March.	April.
Non-alloy steel:					
Ingots, blooms, billets and slabs[5]	5.1	4.9	5.0	5.1	5.5
Heavy rails ..	9.6	9.4	10.1	11.0	11.9
Sleepers, fishplates and soleplates ..	1.9	2.0	3.6	2.6	2.0
Plates ⅛ in. thick and over ..	47.0	46.1	48.4	53.6	55.0
Other heavy prod.	45.8	47.8	49.1	54.4	54.1
Ferro-con. rods etc.	5.9	7.0	7.1	8.4	8.4
Wire rods (incl. coiled rods, etc.)	19.7	22.2	22.9	26.5	25.8
Light rolled prod.	41.2	46.4	45.3	54.7	53.1
Bright steel bars ..	6.3	7.8	7.6	9.3	8.6
Hot-rolled strip ..	21.7	24.1	24.6	27.8	25.9
Cold-rolled strip ..	7.0	8.1	7.3	9.2	8.3
Sheets (incl. coated)	38.8	42.7	44.9	43.8	44.7
Tin, terneplate and blackplate	16.8	17.0	16.6	18.5	17.6
Steel tubes, pipes	20.0	22.9	21.8	28.1	25.7
Tube, pipe fitgs ..	0.4	0.4	0.4	0.5	0.6
Tyres, wheels and axles	4.7	4.8	5.3	5.3	5.5
Forgings (excl. drop forgings) ..	2.6	2.5	2.6	3.3	2.9
Steel castings ..	4.0	4.2	4.0	4.8	4.5
Tool and magnet steel	0.2	0.3	0.3	0.4	0.3
Total	298.7	320.6	326.9	367.3	360.4
Alloy steel	13.2	15.3	15.0	19.0	17.6
Total deliveries from U.K. prod. [6] ..	311.9	335.9	341.9	386.3	378.0
Add: Imported finished steel ..	5.0	18.8	16.7	29.1	29.1
	316.9	354.7	358.6	415.4	407.1
Deduct: Intra-industry conversion[7] ..	41.5	50.4	50.6	57.9	58.9
Total net deliveries of new material ..	275.4	304.3	308.0	357.5	348.2

TABLE IV.— *Production of Pig-iron and Ferro-alloys during May* 1956.

District.	Furnaces in blast.	Hematite.	Basic.	Foundry.	Forge.	Ferro-alloys.	Total.
Derby, Leics., Notts., Northants and Essex	25	0.3	24.2	21.0	0.8	—	46.3
Lancs. (excl. N.W. Coast), Denbigh, Flints. and Cheshire ..	7	—	14.7	—	—	1.6	16.3
Yorkshire (excl. N.E. Coast and Sheffield)							
Lincolnshire ..	10	—	30.9	—	—	—	30.9
North-East Coast	21	4.6	49.1	—	—	0.9	54.6
Scotland	9	0.8	16.3	1.8	—	—	18.9
Staffs., Shrops., Worcs., and Warwick ..	7	—	10.1	1.5	—	—	11.6
S. Wales and Monmouthshire	10	3.3	39.2	—	—	—	42.5
Sheffield	2	—	3.5	—	—	—	3.5
North-West Coast	9	20.5	—	0.2	—	1.2	21.9
Total ..	100	29.5	188.0	24.5	0.8	3.7	248.5[8]
April, 1956 ..	99	28.8	193.9	26.9	0.7	4.0	254.3
May, 1955 ..	99	26.4	178.8	31.6	1.2	3.8	241.8

[1] Used in non-food manufacturing industry.
[2] Weekly average of calendar month.
[3] Stocks, mainly ingots and semi-finished, at the end of the years and months shown.
[4] Five weeks, all tables.
[5] Other than for conversion into any other form of finished steel listed.
[6] Includes finished steel produced in the U.K. from imported ingots and semi-finished steel.
[7] Material for conversion into other products also listed in this table.

House Organs

Ruston Overseas News, Vol. 2, No. 20. Published by Ruston & Hornsby, Limited, Lincoln.

Designed to cater for overseas agents and customers, this house organ well fulfils its purpose by colourfully recording news from all over the world. In this issue there are articles dealing with places in the five continents and about 12 countries. They are well written and splendidly illustrated.

Staybrite Chronicle, Vol. 1, No. 1. Published quarterly for the employees of Firth-Vickers Stainless Steels Limited, Sheffield.

The first story in this new house organ tells of a nomadic foundry making stainless steel castings. Since the foundation about 54 years ago, as far as can be gathered, it has changed its location about half-a-dozen times, and is now housed at the Blackheath plant in the Birmingham area. The booklet is well produced, gives accounts of the works social events, and carries a story by Patsy Hendren. It has made an excellent beginning.

COLT VENTILATION, LIMITED, Surbiton, Surrey, have issued what the publicity people would call an "action leaflet." It calls attention to their survey system of investigating problems and, to enable a survey to be made, or to receive a full-scale catalogue detailing the equipment the company makes, a reply-paid postcard is enclosed. As a piece of publicity it is of a high order as it is convincingly written and illustrated. Readers may avail themselves of this catalogue by writing to Surbiton.

Contracts Open

The dates given are the latest on which tenders will be accepted. The addresses are those from which forms of tender may be obtained. Details of tenders with the reference ESB can be obtained from the Board of Trade Export Services Branch, Lacon House, Theobalds Road, London, W.C.1 (telephone: CHAncery 4411, ext. 738 or 771), unless otherwise stated.

ABERDEEN, August 11—Chains, wire ropes, brass and copper, and cast-iron goods for the year commencing October 1, for the Aberdeen Harbour Commissioners. The Harbour Engineer's Office, 15, Regent Quay, Aberdeen.

AUSTRALIA, August 22—Centrifugal sewage pumps, for the Hunter District Water Board, Newcastle, New South Wales. (ESB/18713/56.)

EGYPT, September 18—Diesel-engined borehole pumps, for the Ministry of Public Works. (ESB/18141/56.)

EIRE, August 18—Marine diesel engines and equipment, for An Bord Iascaigh Mhara. (ESB/18748/56.)

FORMOSA, August 24—Hydraulic jacks, hose couplings, threading machine, riveting hammers, oil furnaces, and air compressor, for the Central Trust of China, Purchasing Department, Taiwan. (ESB/18967/56.)

GUATEMALA, August 9—Equipment, machinery, and accessories for road maintenance and hydro-electric and other products, for the Ministry of Finance and Public Credit. (ESB/18750/56.)

Recent Wills

NICHOLSON, CMDR. E. H. M., a former director of Hadfields, Limited	£25,632
SOWDEN, EDWIN, a partner of Walter Sowden & Sons, metal refiners, of Leeds	£5,328
CAWTHORNE, SAMUEL, chairman of Clayton, Son & Company, Limited, gas and constructional engineers and boilermakers, of Hunslet, Leeds ...	£50,550
CAMPBELL, A. F., formerly managing director of Hardman & Holden, Limited, chemical manufacturers, of Manchester, and a director of other chemical manufacturing concerns	£44,693

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CLASSIFIED ADVERTISEMENTS

PREPAID RATES: Fifteen words for 7/6 (minimum charge) and 4d. per word thereafter. Box Numbers 2/6 extra (including postage of replies.) Situations Wanted 2d. per word.

Advertisements (accompanied by a remittance) and replies to Box Numbers should be addressed to the Advertisement Manager, Foundry Trade Journal, John Adam House, 17/19, John Adam Street, Adelphi, London, W.C.2. If received by first post Monday advertisements can normally be accommodated in the following Thursday's issue.

SITUATIONS WANTED

EXPERIENCED GREY IRON FOUNDRY MANAGER (48), desires appointment. Free to join immediately. Accustomed to full control. Experienced modern fully mechanised plants, employing modern production methods, of light, and medium to heavy castings up to 10 tons.—Box EG230, FOUNDRY TRADE JOURNAL.

FOUNDRY EXECUTIVE (48) desires change; health reasons. 14 years Foundry Manager with firm of repute producing sand and shell moulded repetition grey iron castings. Would consider Technical Representation Foundry Suppliers or similar. Resident Yorkshire, where four figure salary available in exchange for ability and conscientious application.—Box FE226, FOUNDRY TRADE JOURNAL.

METALLURGIST/FOUNDRY TECHNOLOGIST (28), H.N.C., desires progressive position in London. S. or S.E. England. Experienced high duty iron, cupola, sand control; modern foundry methods.—Write Box MF234, FOUNDRY TRADE JOURNAL.

FOUNDRY WORKS MANAGER requires change. Conversant with mechanised plant, floor moulding, shell moulding, core-blowing, quoting and sales. Grey iron.—Box FW237, FOUNDRY TRADE JOURNAL.

SITUATIONS VACANT

WEIGHT ESTIMATOR required for bronze department of large Non-ferrous Foundry in South-East London. Previous experience in this field of weight estimating essential. Applicants should state details of education, experience, etc. Good working conditions. Pension scheme and up-to-date restaurant.—Replies to Box WE240, FOUNDRY TRADE JOURNAL.

INDIA. A progressive Steel Foundry in India requires the following personnel:

1. FOUNDRY SUPERINTENDENT to organise, co-ordinate and control the entire production side of Foundry and to assist in Expansion Project. Salary between £2,000—£3,000 p.a. is envisaged but further consideration will be given to exceptional applicant.

2. FOUNDRY TECHNICIAN to improve castings methods, reduce scrap and design production tackle.

3. SKILLED PATTERNMAKER with administrative experience and ability to train craftsmen, to take complete charge of Patternshop.

Engagement on the basis of a 3-5 year contract. Interviews in London and Sheffield. Company will finance return passages for self, wife and one child. Applications stating age, qualifications and salary required, should be sent with photograph to THE SECRETARY, Indian Chamber of Commerce in Gt. Britain, 20, Wormwood Street, London, E.C.2.

ESTIMATOR required with experience in Foundry and Pattern Making Practice. Applications in writing to give age, experience and present salary to G. D. PETERS & Co., LTD., Windsor Works, Slough, Bucks.

SITUATIONS VACANT—*contd.*

FOUNDRY TECHNICAL ASSISTANT required for 50-ton per week iron-foundry, to take charge of routine technical control and to assist with new developments. Interesting position, with good prospects.—Write in confidence, giving age, experience, and salary required, to Box FT227, FOUNDRY TRADE JOURNAL.

FOREMAN required for Mechanised Pipe Plant in Central Scotland. Will be expected to recruit and train labour team. Sand Slinger experience essential.—Apply Box CS228, FOUNDRY TRADE JOURNAL.

FOUNDRY FOREMAN, experienced executive for Roll Foundry and other castings.—State experience, qualifications, and wages required, Box FF974, FOUNDRY TRADE JOURNAL.

MACHINE MOULDER wanted.—MOYLE, Iron Foundry, Kingston-on-Thames.

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Applicants should possess an H.N.C. in Chemistry and have some practical experience in the application of pre-treatment and protective finishes to ferrous and non-ferrous materials for both indoor and out-door use.

Housing assistance can be offered to suitable applicants.

Reply in confidence to Box FTJ 876 LPE., 55 St. Martin's Lane, London, W.C.2.

RAINWATER AND SOIL CONNECTION MOULDERS urgently required. Apply KINGSWORTHY FOUNDRY CO. LTD., Kingsworthy, Winchester.

DESIGNER DRAUGHTSMEN seeking situations affording opportunities for advancement are invited to submit applications to fill vacancies in a small but modern drawing office. It would be an advantage if applicants had previous experience in one of the following categories:—Gravity Diecasting Design, Pressure Diecasting Design, Jig and Tool design.—Write, giving full particulars, to PERSONNEL OFFICER, West Yorkshire Foundries, Ltd., Sayner Lane, Leeds, 10.

FOUNDRY SUPERINTENDENT required for Large Jobbing Steel Foundry, North West Area. Progressive Staff appointment, and good salary paid commensurate with the practical and technical qualifications of the applicant. All applications will be treated in strict confidence. Full details, stating age and salary required to Box FS211, FOUNDRY TRADE JOURNAL.

SITUATIONS VACANT—*contd.*

THE HIGH COMMISSIONER OF INDIA.

APPLICATIONS are invited for the following posts with Defence Factories under Government of India, Ministry of Defence:—

(1) ONE MACHINE TOOL DESIGNER.
(2) ONE MECHANICAL OPTICAL DESIGNER.
(3) ONE TOOL MAKER AND TOOL DESIGNER.
(4) TWO FOUNDRY ENGINEERS.

Qualifications:—Candidates for (1) should possess degree in Mechanical Engineering and/or be member of Institute of Mechanical Engineers. Have eight years' experience in design of machine tools, including hydro-mechanical components, and experience in manufacture, assembly and testing of such tools. Age between 40 and 50 years. For (2) Degree or diploma in Mechanical Engineering and/or served apprenticeship with firm of repute manufacturing optical and scientific instruments. 10 years' experience with such a firm. Capable of designing framework and operating gear for housing optical arrangements. Working knowledge of production of optics and specialised knowledge of mechanical problems connected with manufacture of optical stores. Age between 40 and 45 years. For (3) Degree in Mechanical Engineering, or equivalent, with about 15 years' experience in design and manufacture of tools, jigs, fixtures and gauges. Should possess essential knowledge of modern methods of manufacture of broaches, screw gauges, full form chamber gauges, etc., including their heat treatment and finishing. Age between 40 and 50 years. For (4) Degree in Metallurgy or full member of Institute of British Foundrymen or similar institute. 10 years' experience in fully mechanised steel foundry manufacturing light, medium and heavy steel castings. Ability to suggest improvements to increase out-turn of quality steel castings. Age between 45 and 50 years. Age limits may be relaxed in exceptional cases.

Terms:—Appointment on contract for three years in first instance. Sea passages. Free medical attendance. Travelling allowance. Leave 1/11th of period of duty. Exemption of Income Tax. Pay in accordance to qualifications and experience.

Further details and forms of application on request, quoting 16/2K, from the HIGH COMMISSION OF INDIA, Establishment Department, India House, Aldwych, London, W.C.2.

Last date for receipt of applications: 24th August 1956.

ANALYTICAL CHEMIST, male or female, 20-26 years, for new Brownhills foundry. Knowledge of ferrous analysis essential, Sand Testing and control an advantage. Write stating experience, qualifications and salary, etc., to CASTINGS, LTD., Selborne Street, Walsall.

FOUNDRY FOREMAN ASSISTANT, Mechanised Malleable Foundry. Opportunity for young person with Metallurgical, Pattern Shop and practical experience to qualify for Foundry Management. Apply stating qualifications, salary, etc., to Box FF241, FOUNDRY TRADE JOURNAL.